



JET PROPULSION LABORATORY

ISSM Workshop 2011

JPL

Ice Sheet System Model ISSM Capabilities

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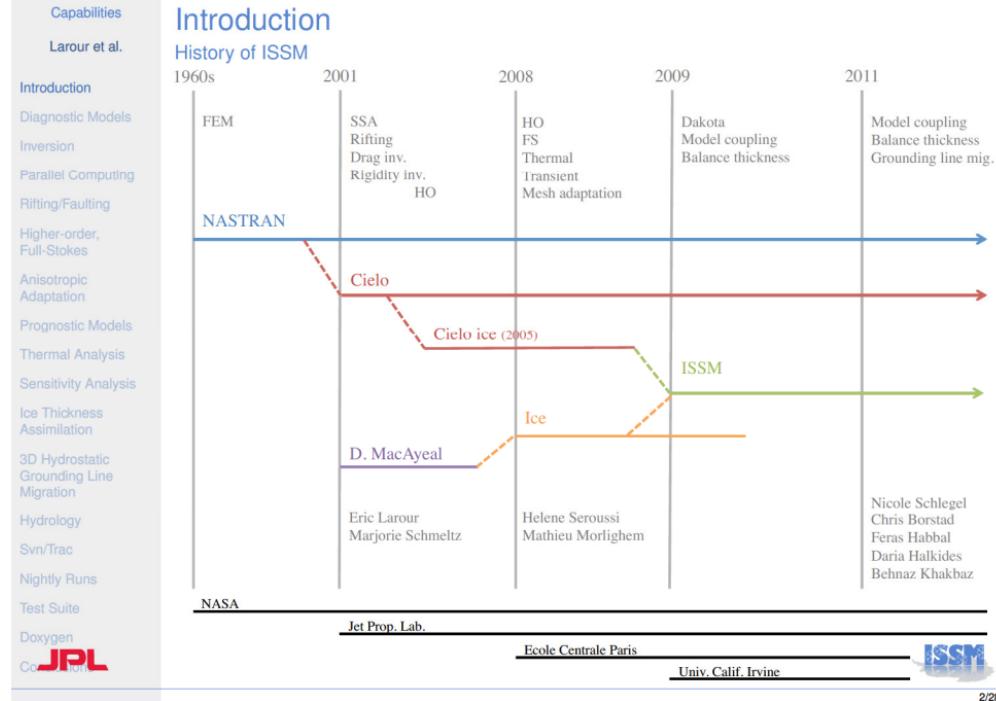
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Diagnostic models of ice flow

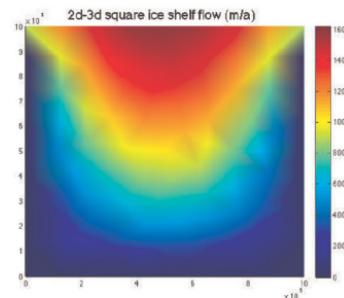
Solve mechanical stress-equilibrium for the entire ice sheet/ice shelf. Can be done in 2D (SSA) or 3D (SIA, Higher-order, Full-Stokes). Material is isotropic nonlinear (Glen's law) in the creep regime of deformation.

$$\nabla \bullet \vec{V} = 0$$

$$\rho \frac{d\vec{V}}{dt} = \nabla \bullet \sigma + \rho \vec{g}$$

$$\dot{\sigma}_{ij} = 2\eta \dot{\varepsilon}_{ij}$$

$$\eta = \frac{1}{2} A(\theta)^{-\frac{1}{n}} \left(\dot{\varepsilon} + \dot{\varepsilon}_0 \right)^{\frac{(1-n)}{n}}$$



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Inversion

Rely on surface velocities (InSAR) to invert unknown parameters in the ice flow equations, such as viscosity, ice rigidity or basal drag.

$$\begin{aligned}
 J' = & \iint_S \frac{1}{2} \left\{ (u - u_{obs})^2 + (v - v_{obs})^2 \right\} dx dy + \\
 & \iint_S \lambda(x, y) \left\{ \frac{\partial}{\partial x} \left(2vH \left(2 \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \right) \right) + \frac{\partial}{\partial y} \left(vH \left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} \right) \right) - \rho g H \frac{\partial z_s}{\partial x} - \beta^2 u \right\} dx dy + \\
 & \iint_S \mu(x, y) \left\{ \frac{\partial}{\partial y} \left(2vH \left(2 \frac{\partial v}{\partial y} + \frac{\partial u}{\partial x} \right) \right) + \frac{\partial}{\partial x} \left(vH \left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} \right) \right) - \rho g H \frac{\partial z_s}{\partial y} - \beta^2 v \right\} dx dy \\
 \frac{dJ'}{d\beta} = & -2 \iint_S \{ \lambda u + \mu v \} \beta \delta \beta dx dy
 \end{aligned}$$



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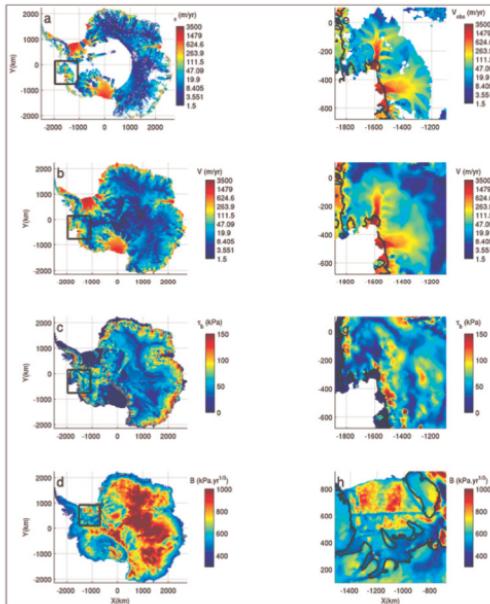
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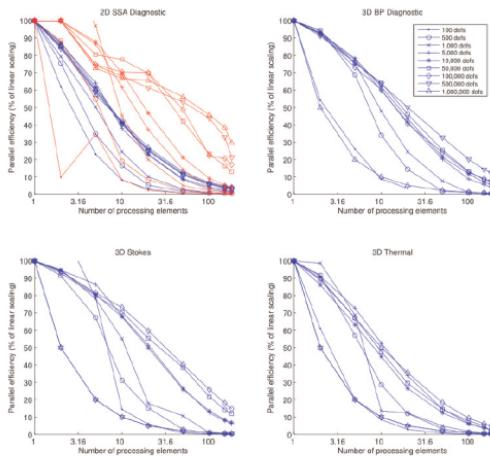
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Parallel computing

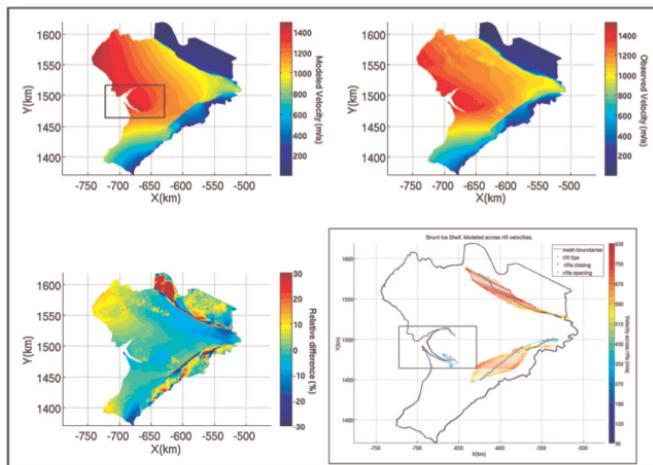
- ISSM can run on any platform (multi-core desktop), shared or distributed cluster
- C++ implementation of computational core using MPICH and PETSc libraries + array of parallel libraries for partitioning, iterative and direct solvers
- Multi-threading of pre and post-processing modules to increase speed significantly



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Rifting/Faulting

ISSM can account for the presence of rifts and faults in an ice shelf by carrying out a steady-state computation of the contact within the rifts/faults.



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Rifting/Faulting

- Rifting and faulting account for contact stresses and the presence of melange
- This is not an initiation or propagation capability
- Relies on penalty methods to enforce contact conditions between flanks of rifts
- Relies on diagnostic model to compute stresses across ice shelf
 - This is not an LEFM capability. It assumes the entire ice shelf is creeping, and there is no inclusion of elastic stresses



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Higher-order and Full-Stokes modeling

- ISSM relies on the the 2D SSA to capture longitudinal stresses, 3D Blatter/Pattyn to capture vertical shear stresses and full-Stokes equations to capture all stresses within the ice sheet
- Activation of all three formulations is seamless, relying on almost the same model setup
→ experimentation is easy
- Coupled with parallel computing and anisotropic meshing, higher-order modeling at the continental scale is achievable with reasonable resolutions

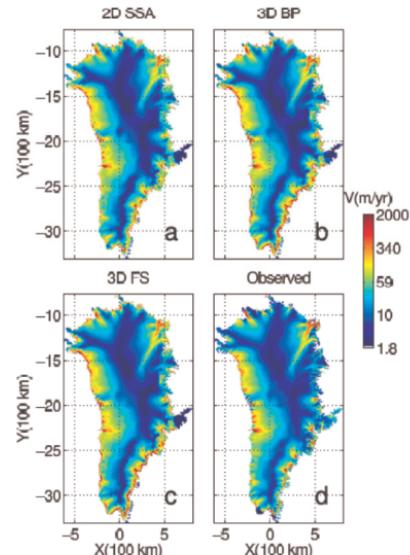


Figure 8. Modeled surface velocity (m/yr) (using inversion based on differential GPS) for the (a) 2D SSA model and the (b) 3D Blatter/Pattyn model (b) and the 3D full-Stokes model (c). (d) Observed InSAR surface velocity (m/yr) of the Greenland ice sheet.



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Anisotropic adaptation

- Adapt mesh according to a metric, such as surface velocity
- Static capability, not transient adaptation
- Relies on a rewrite of the BAMG anisotropic mesher [Hecht, 2006]

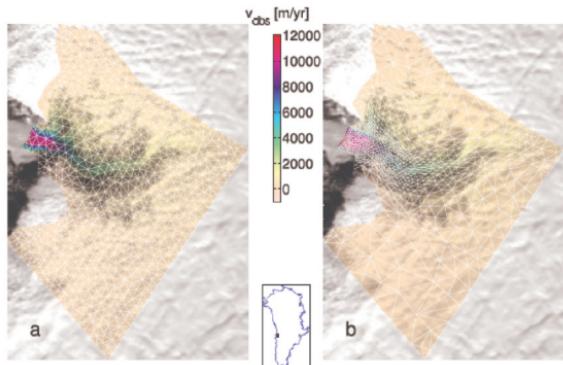


Figure 2: Anisotropic adaptive mesh of Jakobshavn Isbrae, West Greenland. a) InSAR surface velocity interpolated on a uniform mesh, b) InSAR surface velocity from Rignot [2008] interpolated on adapted mesh (in white). Both meshes comprise 1,500 elements.

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Prognostic modeling

- Mass transport equations:

$$\frac{\partial H}{\partial t} + \nabla \cdot H \bar{v} = \dot{M}_s - \dot{M}_b$$

- Update of surface and bed is hydrostatic on ice shelves. For ice sheets, surface is updated assuming the bedrock is fixed
- Mass transport equations are coupled with diagnostic and thermal models to allow for complete transient models to be run (SeaRISE 2011)
- Boundary conditions assume fixed thickness at the ice divide, and free flux of mass at the calving front or the grounded margins
- Calving front dynamics not included yet
- Grounding line dynamics is hydrostatically treated



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Co-simulation

Thermal modeling

- Thermal model, full-advection and full-diffusion in 3D + viscous heating. Mesh velocity in vertical direction.

$$\frac{\partial T}{\partial t} = (\mathbf{w} - \mathbf{v}) \cdot \nabla T + \frac{k_{th}}{\rho c} \Delta T + \frac{\Phi}{\rho c}$$

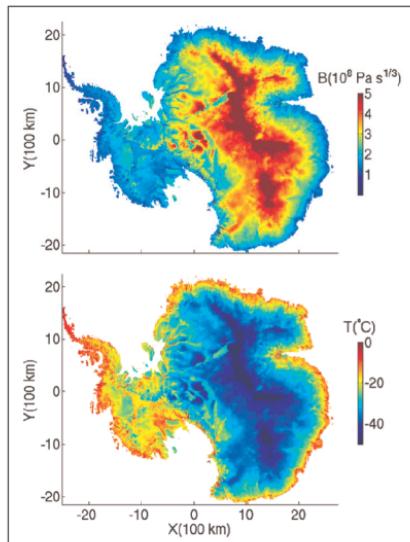
- Boundary conditions:

- $T = T_s$ at surface
- At ice/bed interface:

$$k_{th} \nabla T \cdot \mathbf{n} = G - \tau_b \cdot \mathbf{v}_b$$

- [Holland and Jenkins, 1999] at the ice/ocean interface:

$$k_{th} \nabla T \cdot \mathbf{n} = -\rho_w c_p M \gamma (T - T_f)$$



Melting at the ice/bed interface

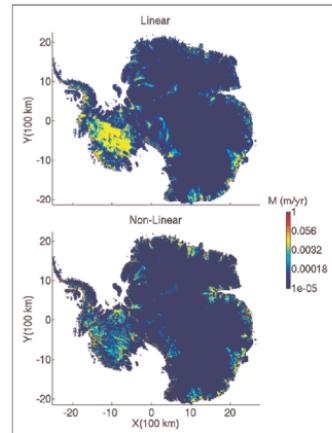
- Two models for computing melting rates:

- Linear model where computation of temperatures is updated once for each temperature that goes above pressure melting point
- Non-linear model where fixed-point scheme is used, where temperatures are updated until all of temperature field is below or at pressure melting point

Melting rate is recovered using:

$$S = \frac{\lambda}{\rho_{ice} L} \left(\frac{dT^*}{dz} - \frac{dT}{dz} \right)$$

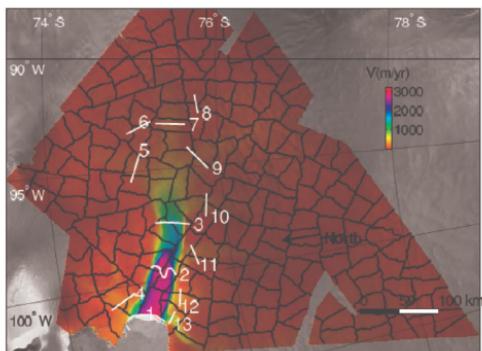
where T^* is the temperature without pressure melting point constraints and T is the temperature after application of constraints. Non-linear model results in much lower melting rates, even though locations for melting are similar. It is critical to take into account non-linearity of thermal model, at least in steady-state!



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Sensitivity analysis

- Sampling and local reliability methods to study the impact of different areas of the mesh
- Sampling of the mesh using Chaco, Scotch and Metis partitioners
- Partition the mesh into equal area sections, which can be then updated for each sample of a Monte-Carlo or local reliability simulation



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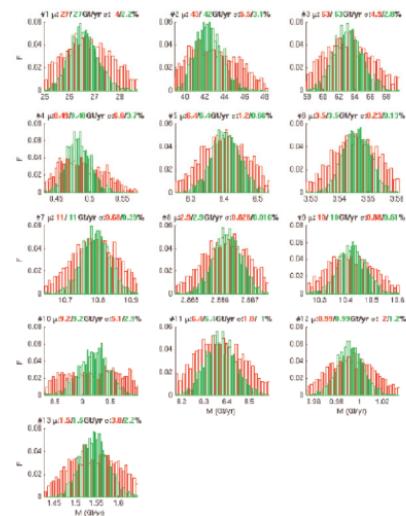
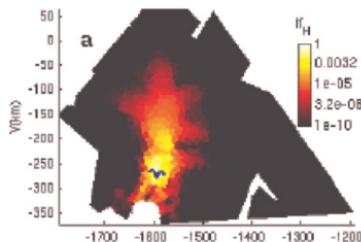
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Sensitivity analysis

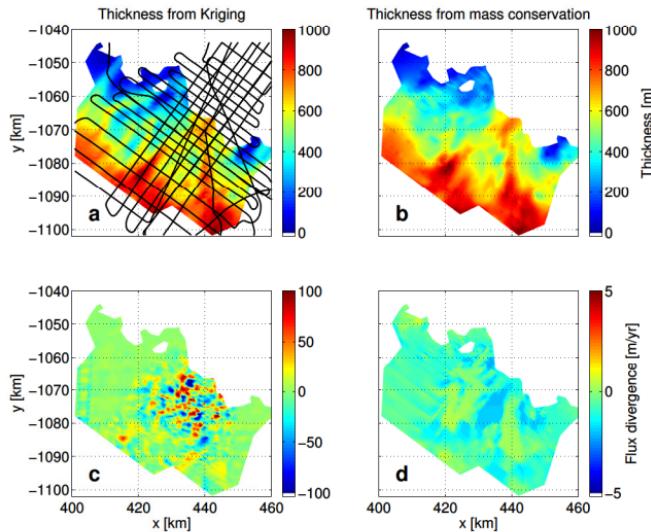
- Results can then be plotted in histograms for sampling analysis or importance factors for local reliability methods



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Assimilation of ice thickness (balanced thickness)

- Ice thickness can be optimized to ensure smooth divergence of the flux (thinning rate). Optimization can be constrained (on satellite or airborne tracks where data was measured) or unconstrained



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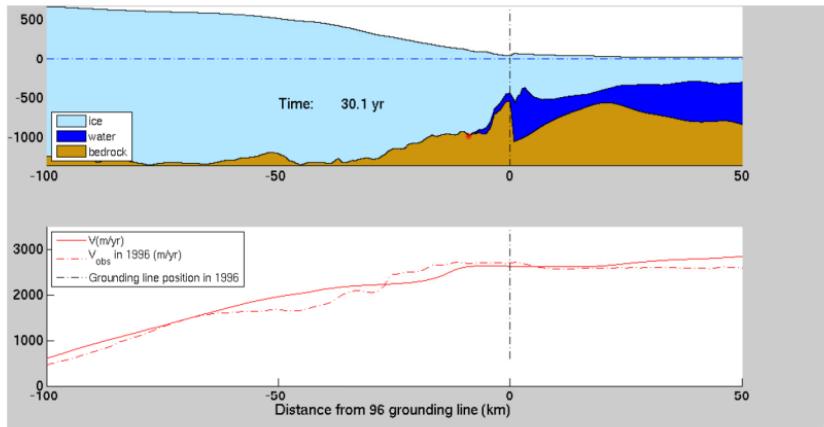
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- At each time step of the transient ice flow solution, we check the following for every vertex of the mesh:
 - $b \leq b_a$ where b_a is the depth of the glacier bed or seafloor. For most ice sheet/ice shelf configurations, b is negative. If this condition is verified for a floating vertex (i.e., on an ice shelf), we ground the vertex and force $b = b_a$
 - $b > b_{HE}$ where b_{HE} is the depth of the bottom of the ice in hydrostatic equilibrium: $b_{HE} = H\rho/\rho_w$. If this condition is verified for a grounded vertex (i.e., on the ice sheet), we unground the vertex and force $b = b_{HE}$



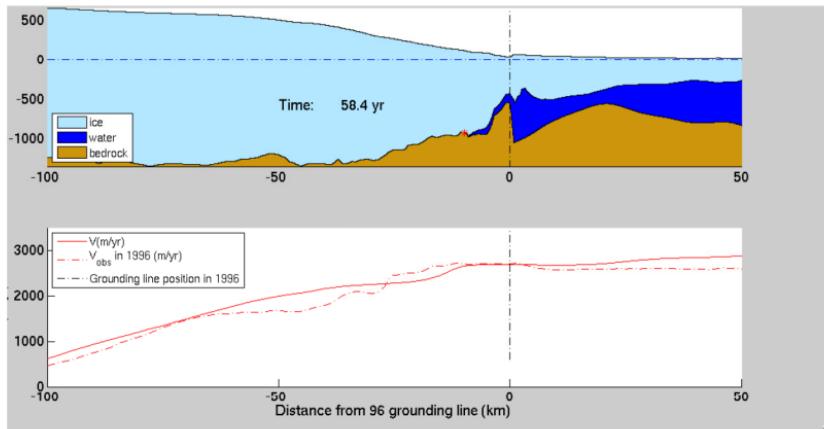
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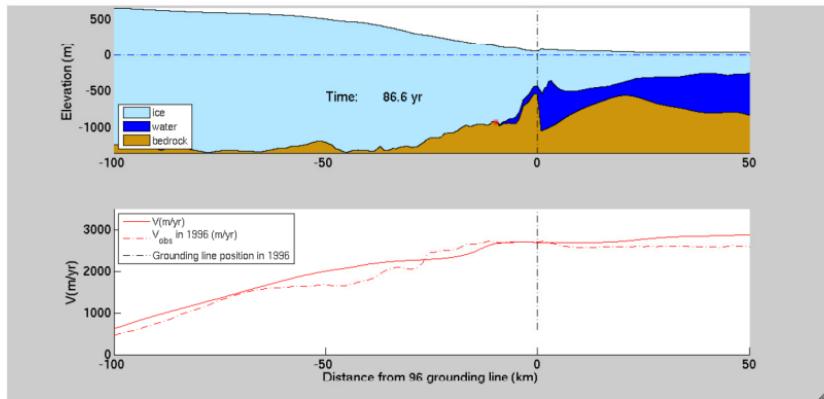
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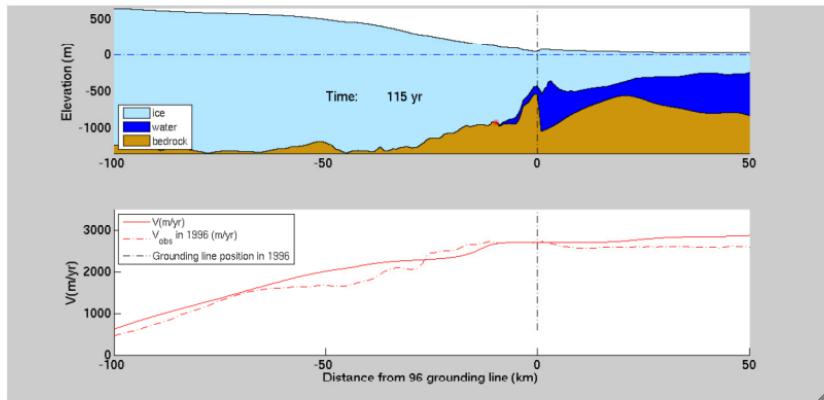
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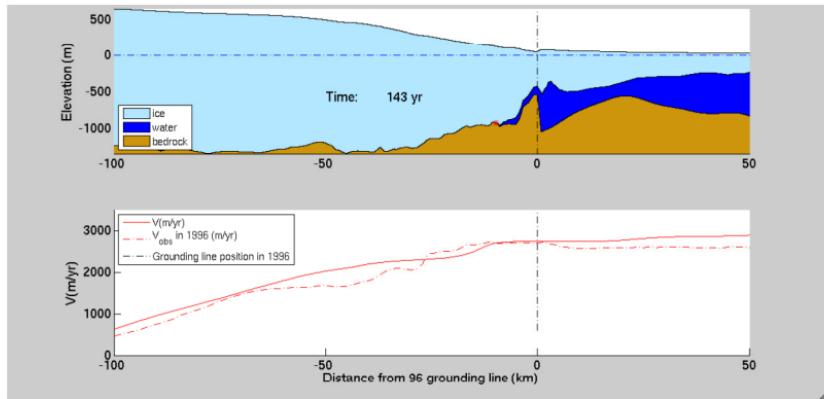
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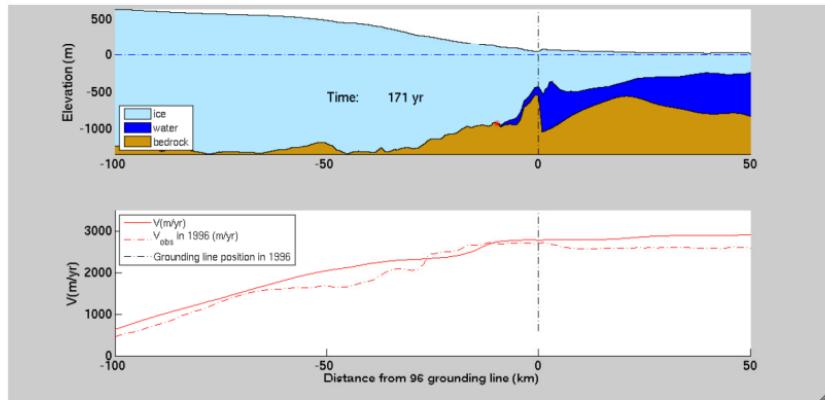
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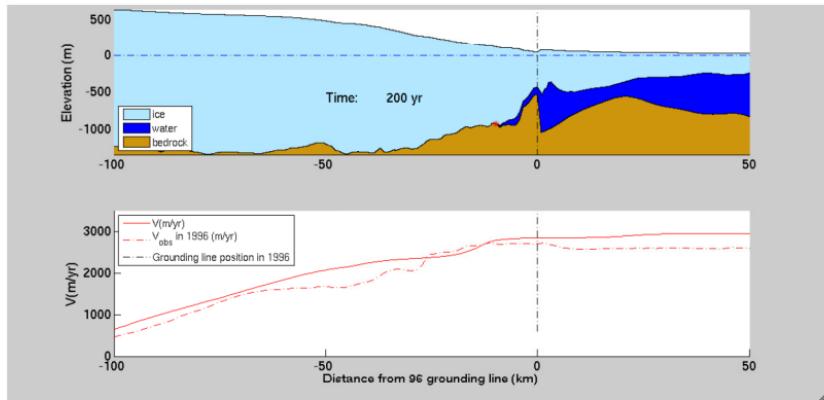
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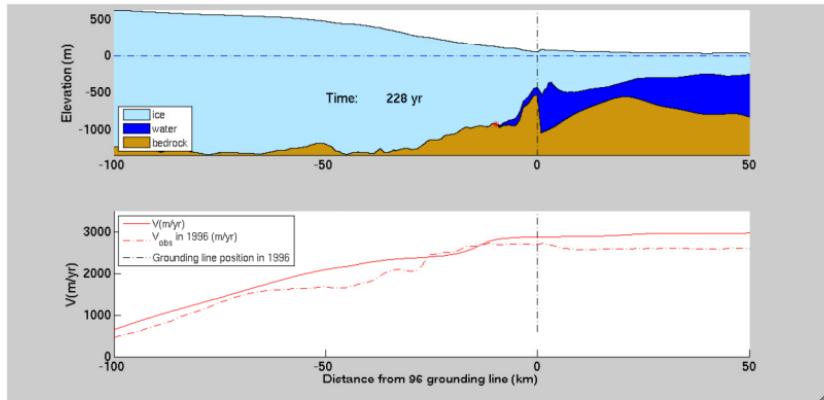
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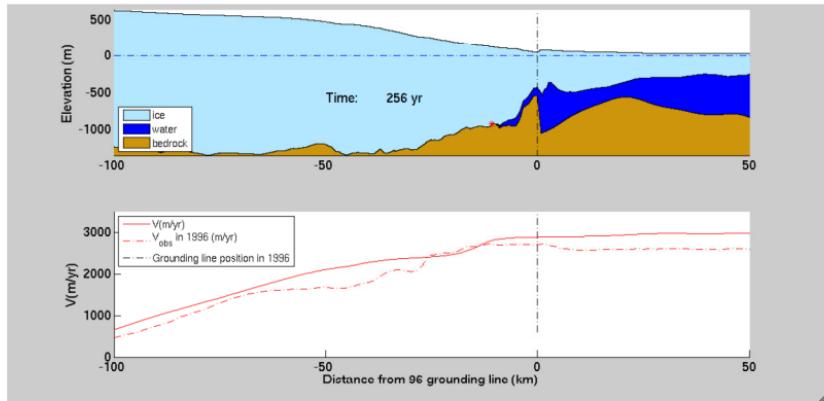
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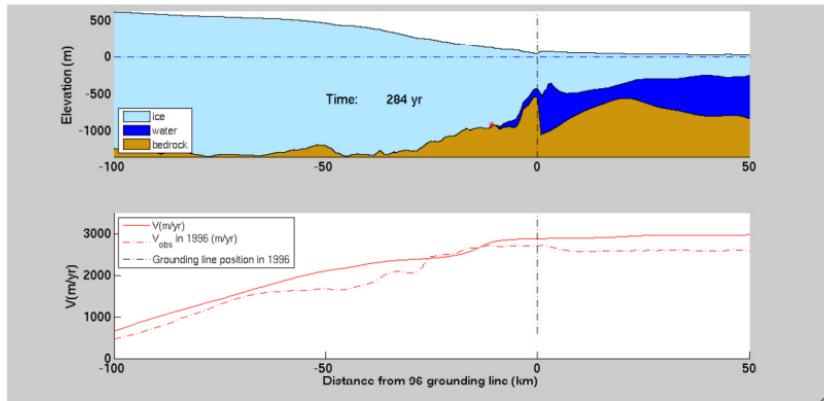
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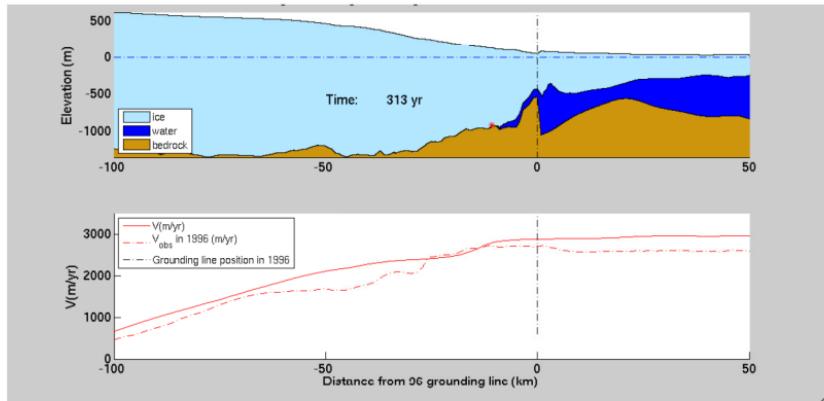
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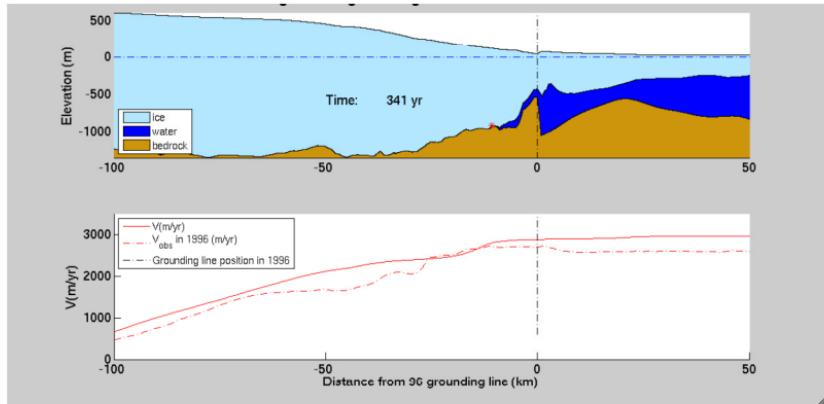
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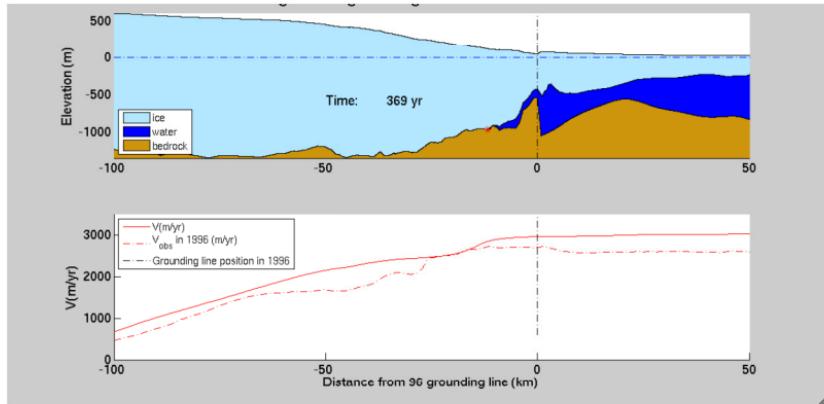
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3D Hydrostatic grounding line migration



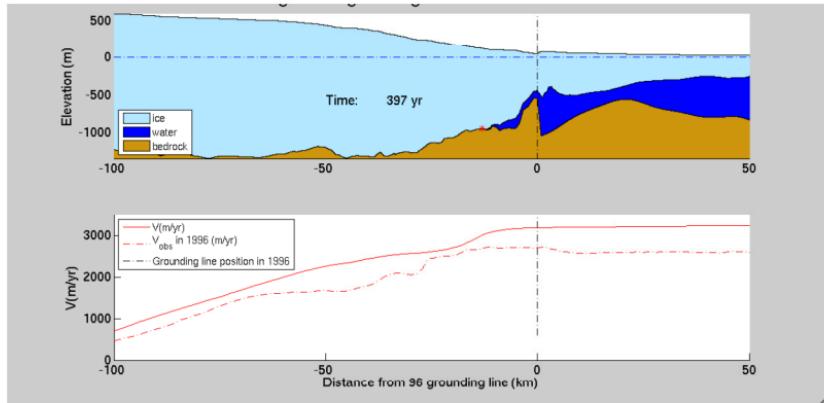
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3D Hydrostatic grounding line migration



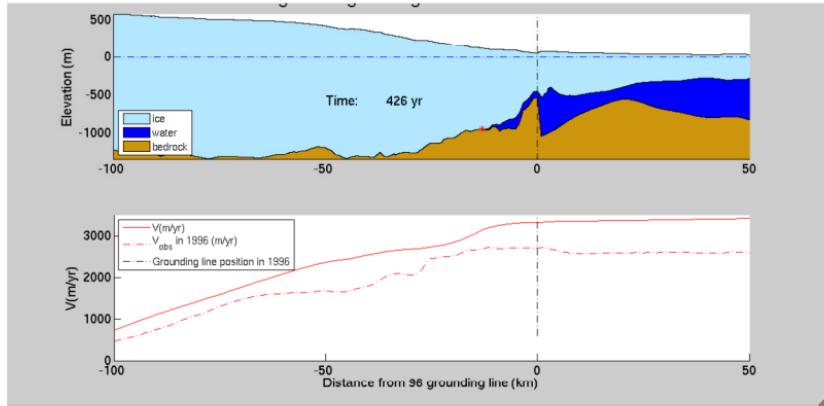
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3D Hydrostatic grounding line migration



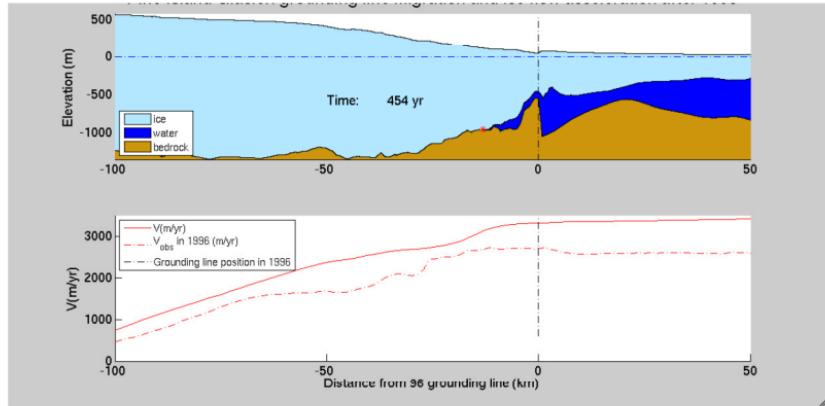
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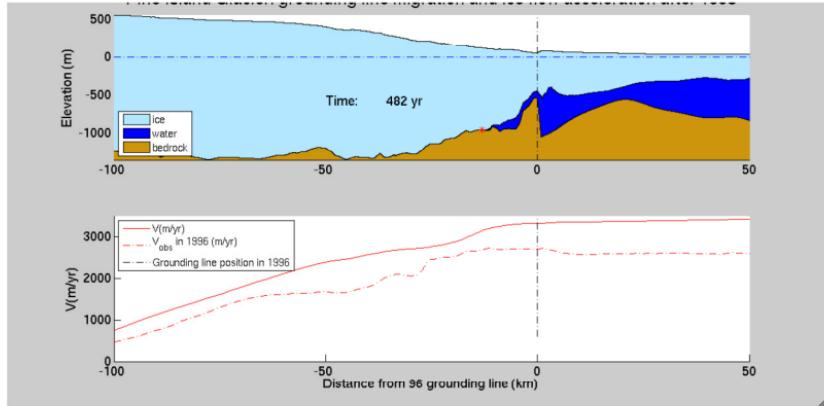
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3D Hydrostatic grounding line migration



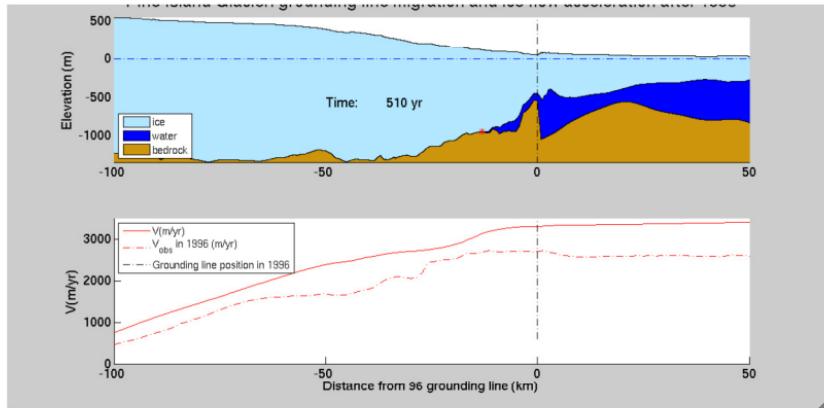
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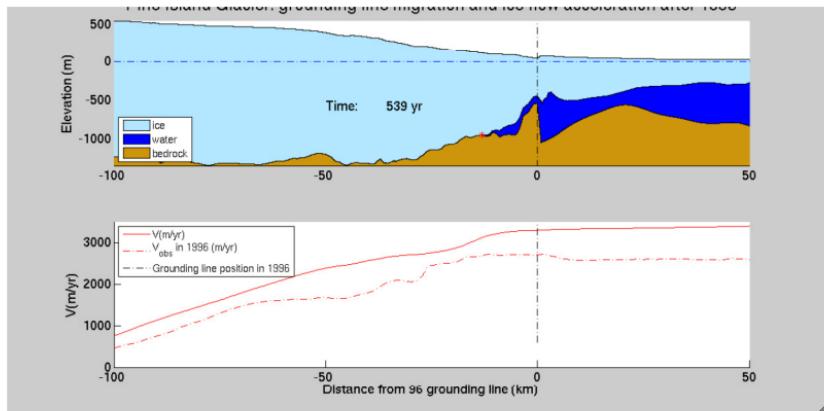
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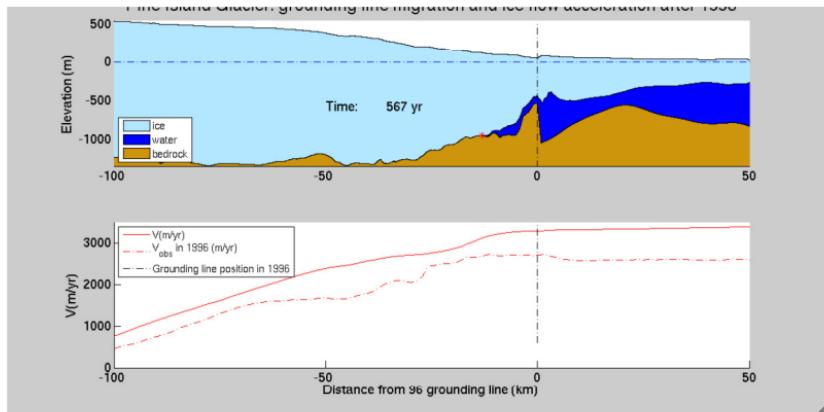
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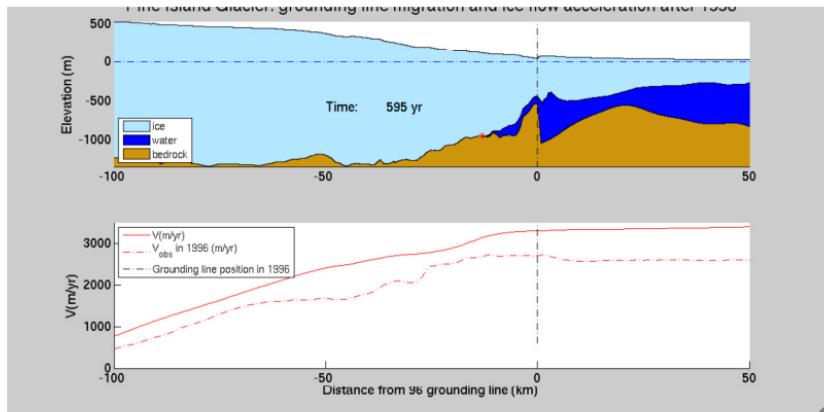
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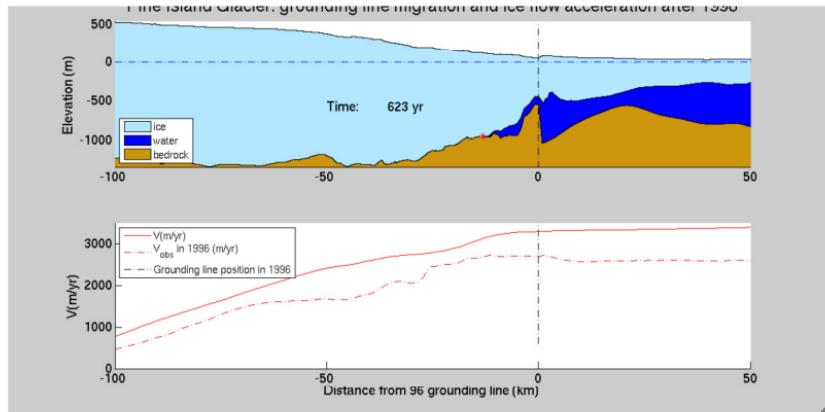
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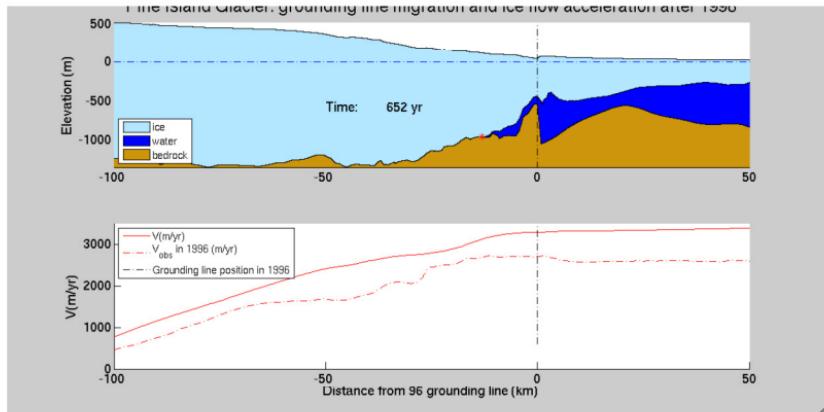
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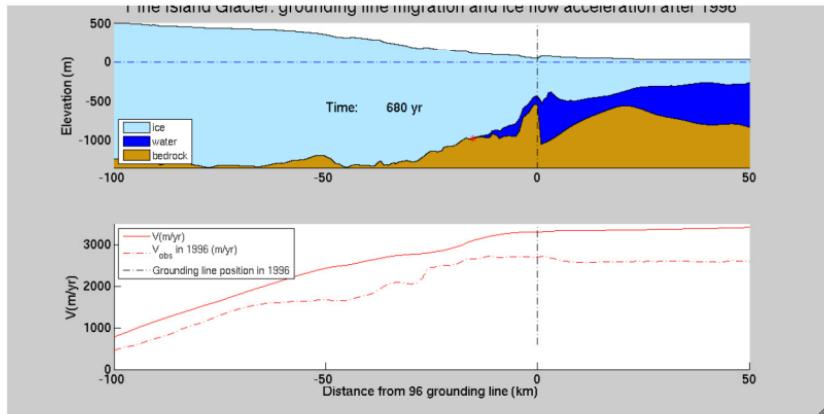
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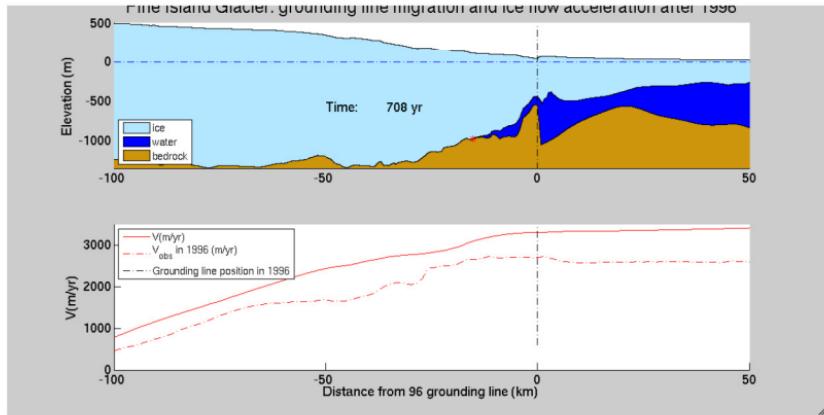
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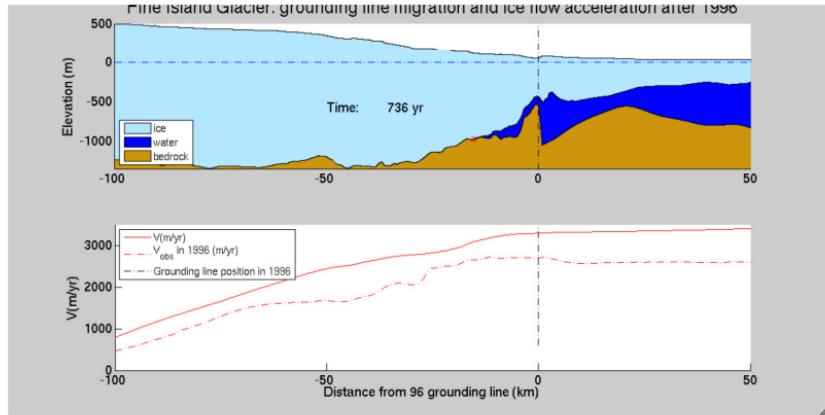
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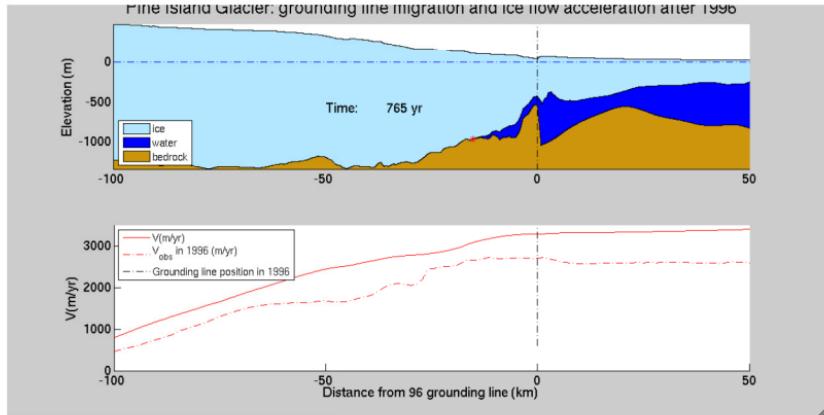
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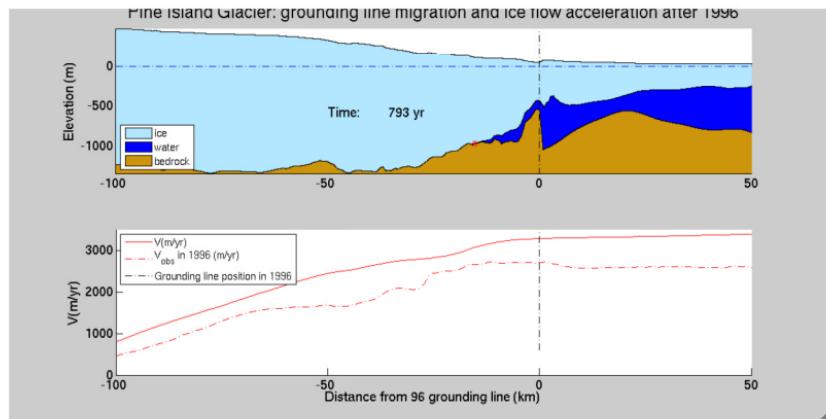
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3D Hydrostatic grounding line migration



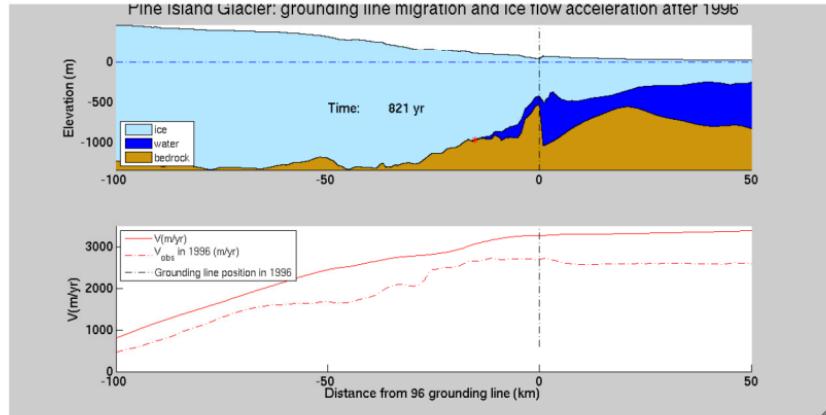
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3D Hydrostatic grounding line migration



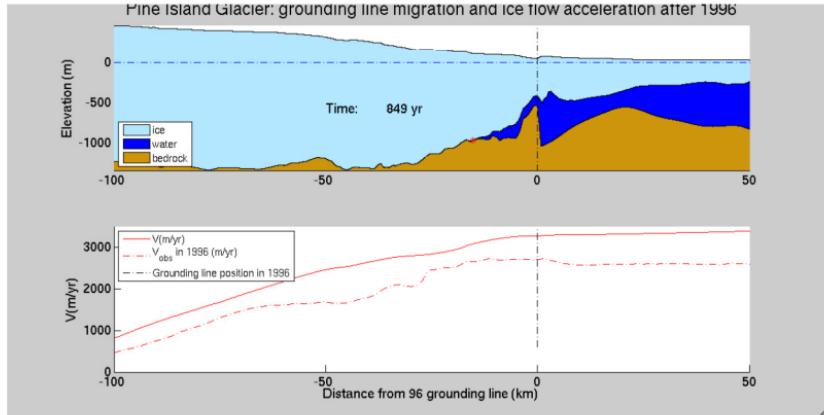
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3D Hydrostatic grounding line migration



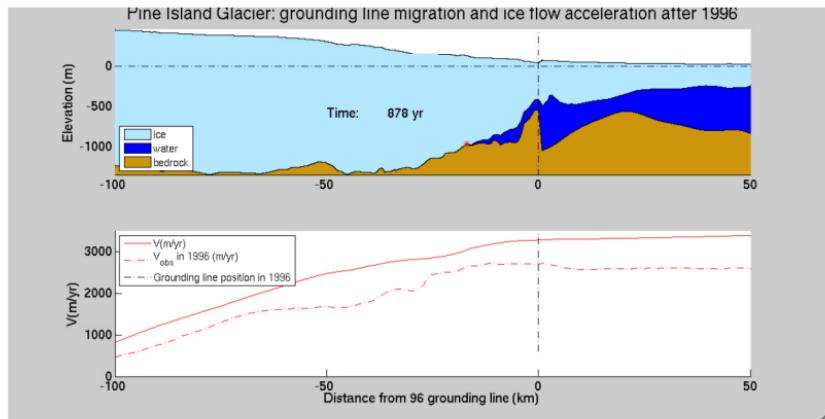
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3D Hydrostatic grounding line migration



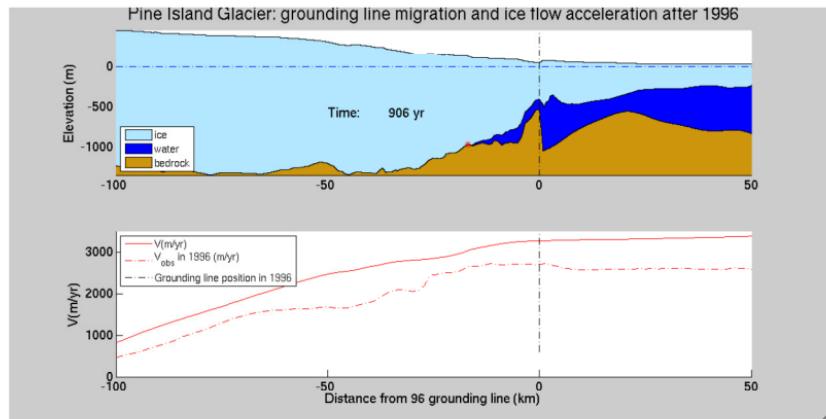
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3D Hydrostatic grounding line migration



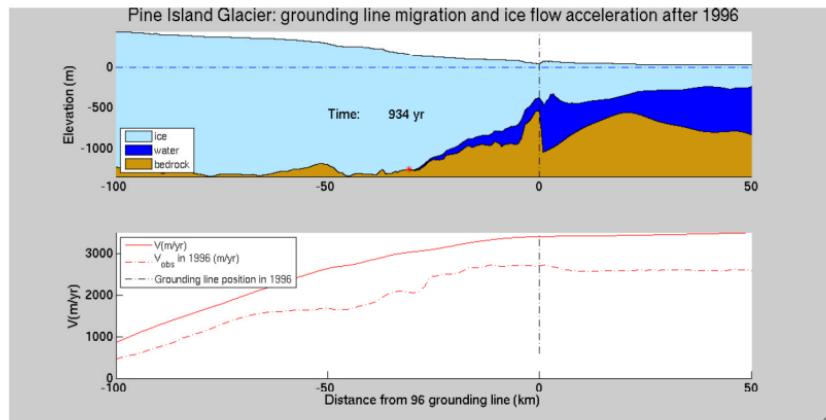
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3D Hydrostatic grounding line migration



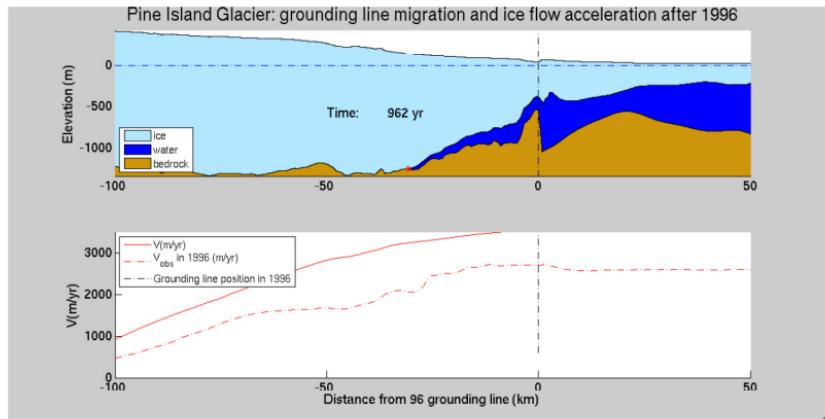
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3D Hydrostatic grounding line migration



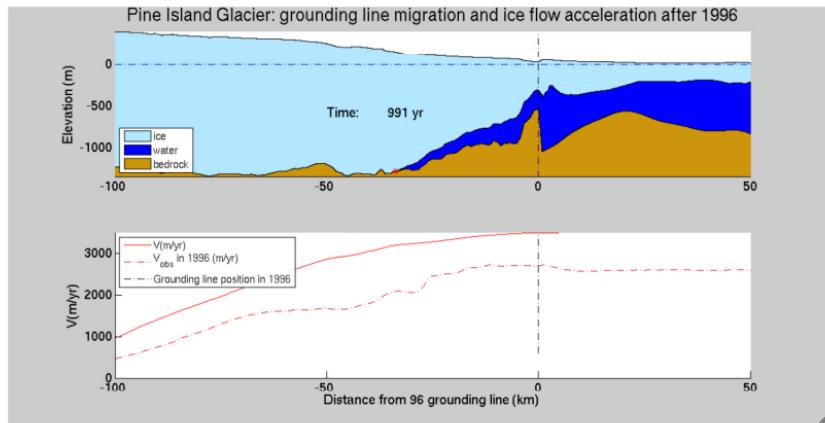
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3D Hydrostatic grounding line migration



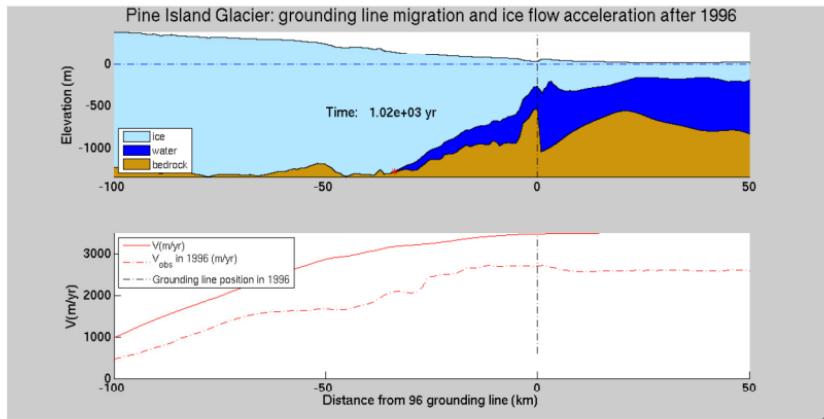
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3D Hydrostatic grounding line migration



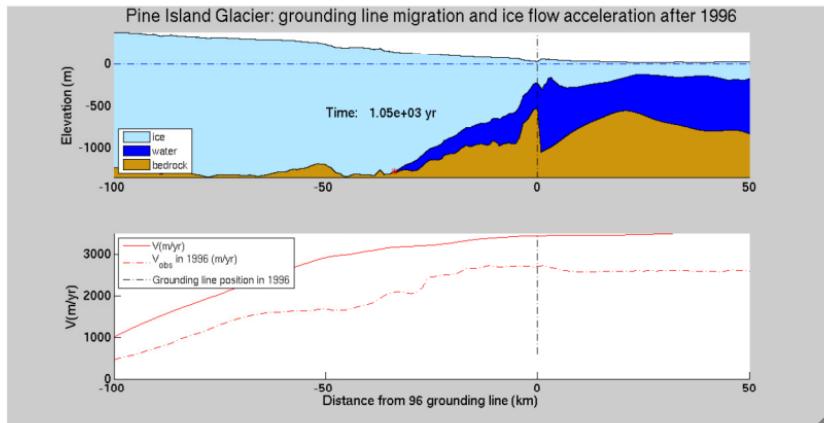
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3D Hydrostatic grounding line migration



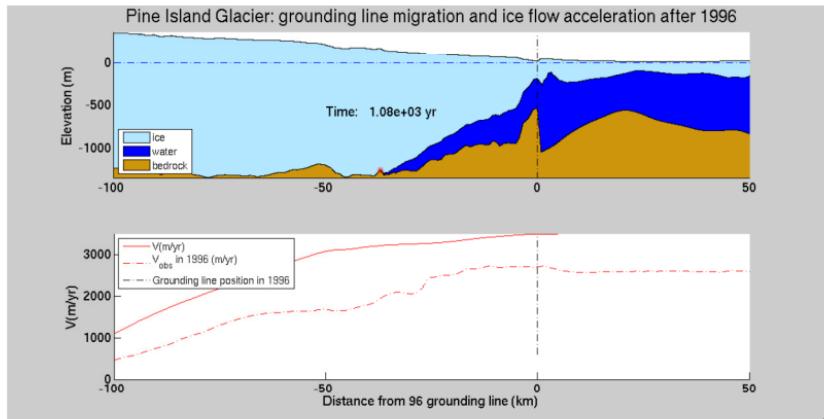
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3D Hydrostatic grounding line migration



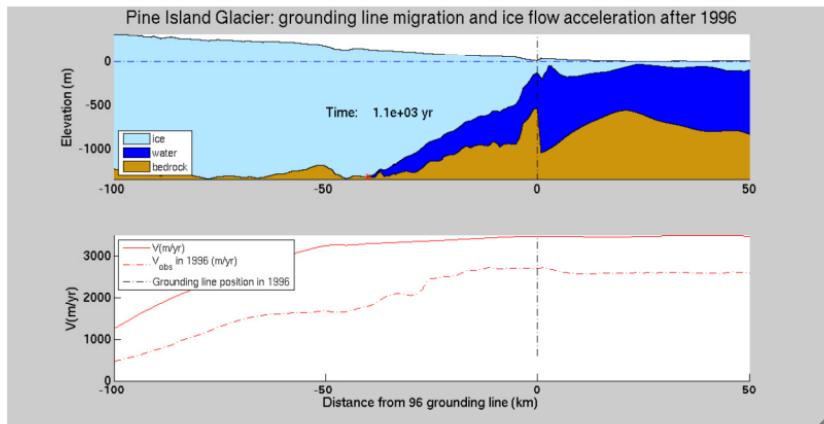
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3D Hydrostatic grounding line migration



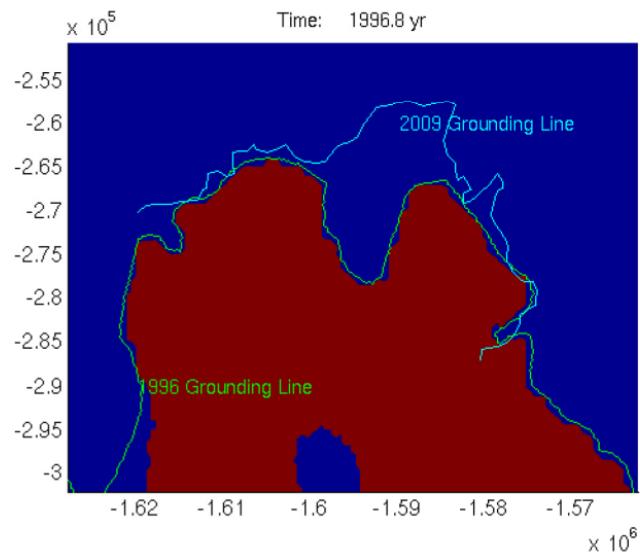
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3D Hydrostatic grounding line migration



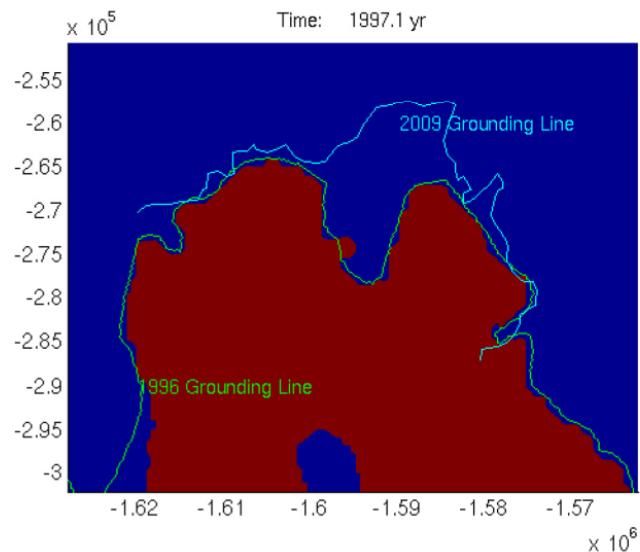
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3D Hydrostatic grounding line migration



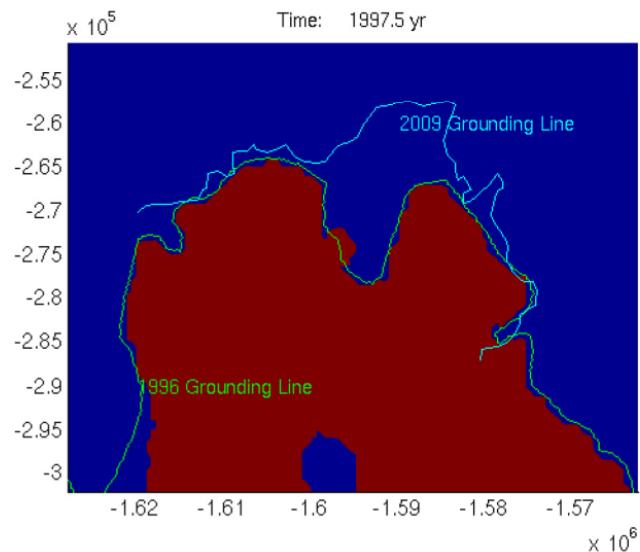
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3D Hydrostatic grounding line migration



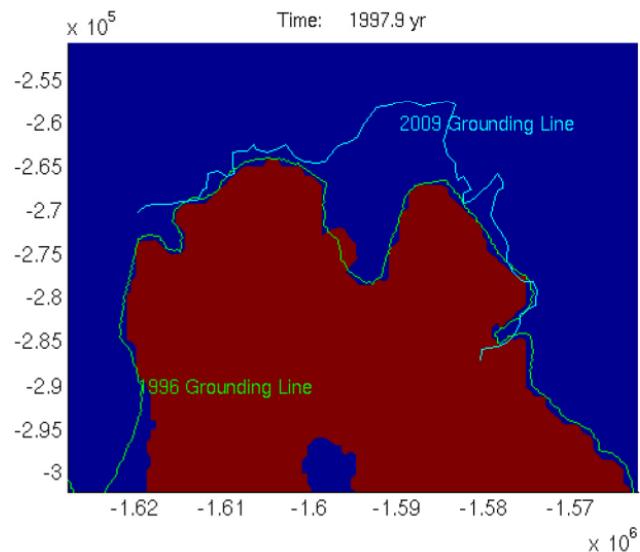
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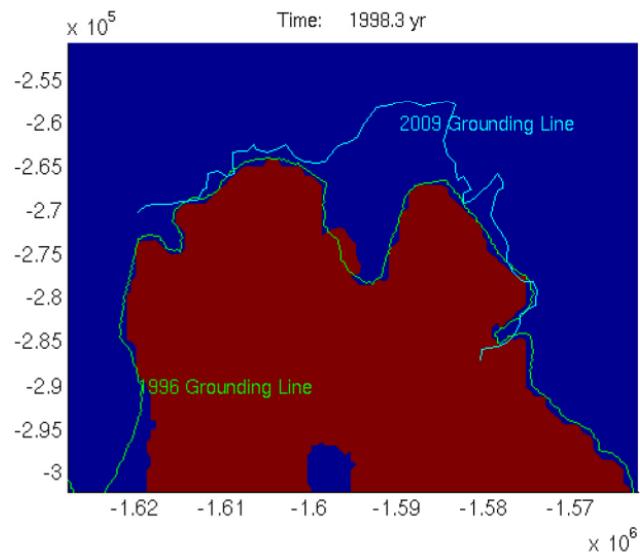
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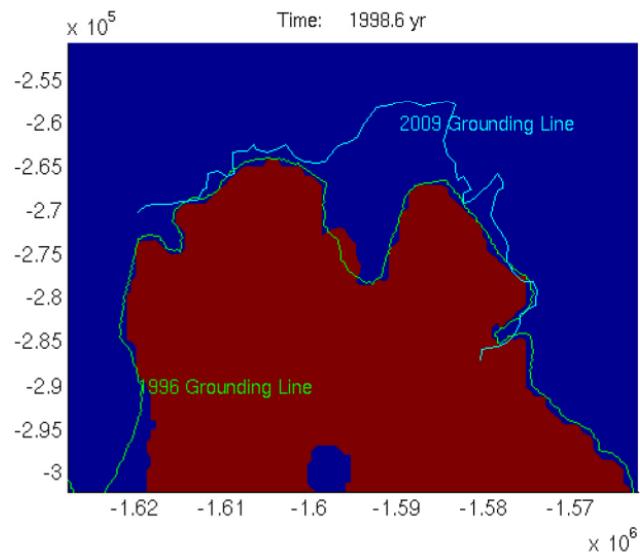
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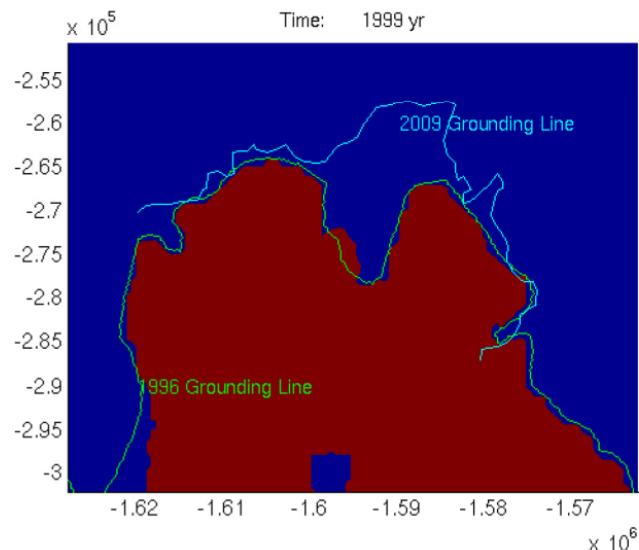
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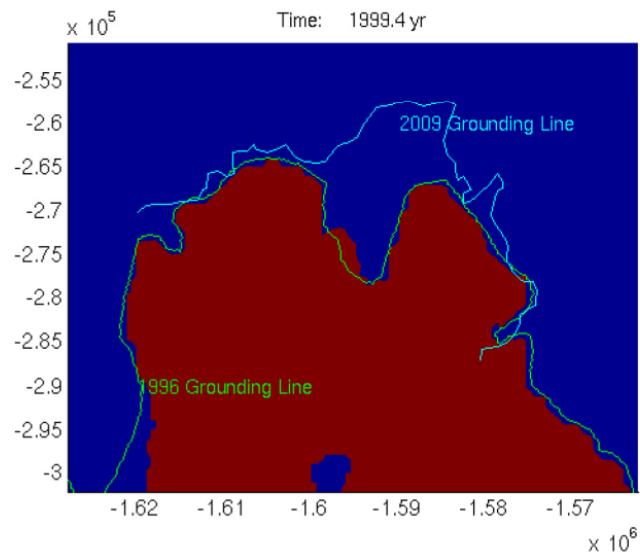
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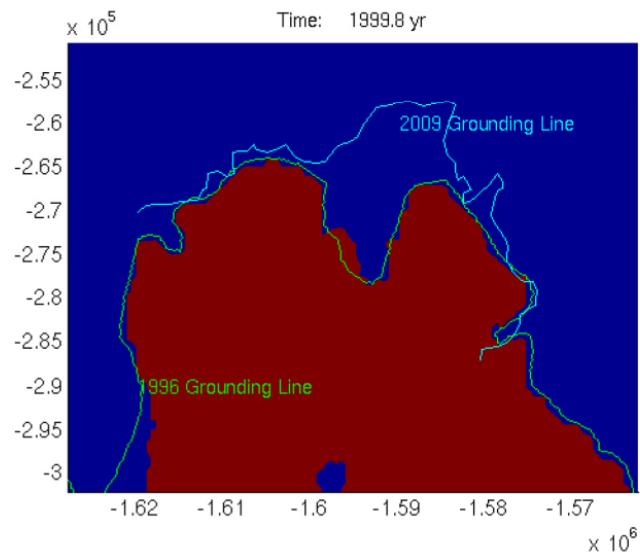
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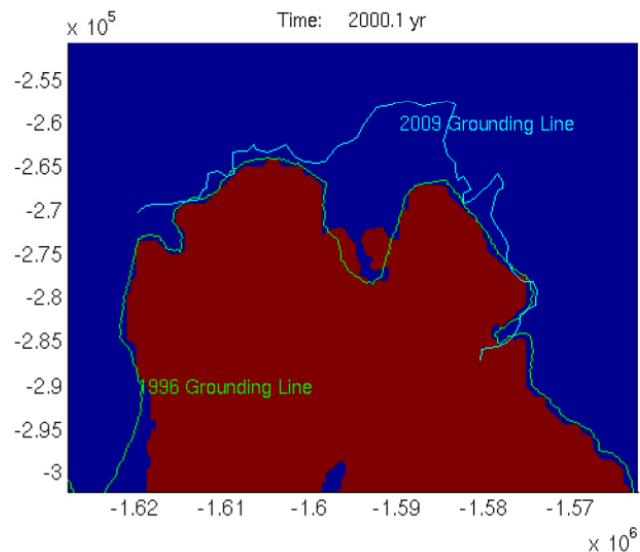
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3D Hydrostatic grounding line migration



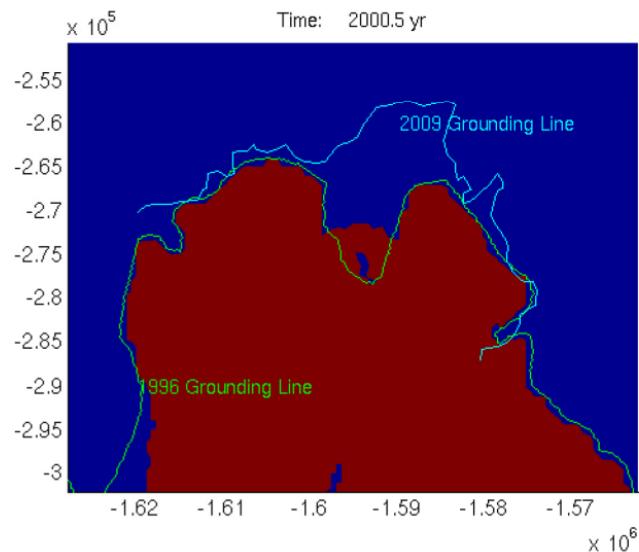
[Capabilities](#)[Larour et al.](#)[Introduction](#)[Diagnostic Models](#)[Inversion](#)[Parallel Computing](#)[Rifting/Faulting](#)[Higher-order,
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3D Hydrostatic grounding line migration



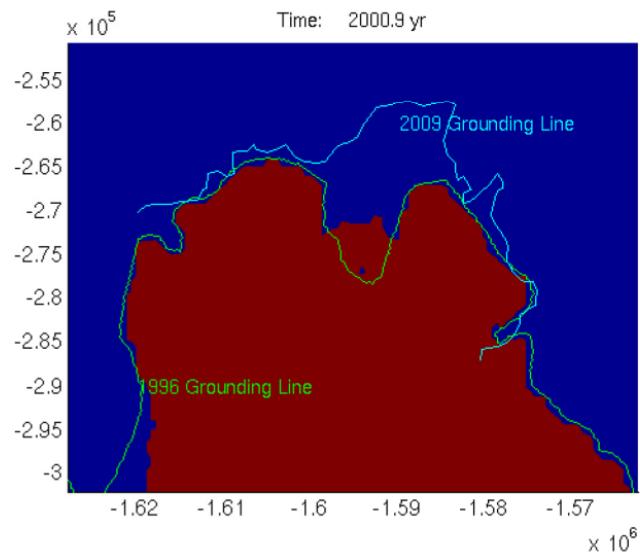
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3D Hydrostatic grounding line migration



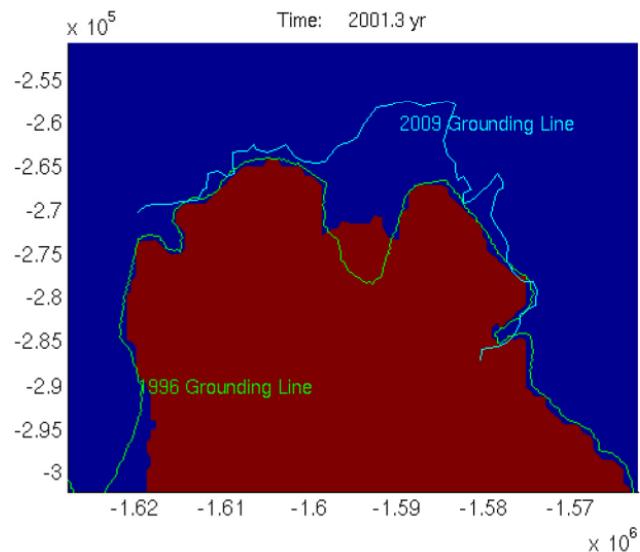
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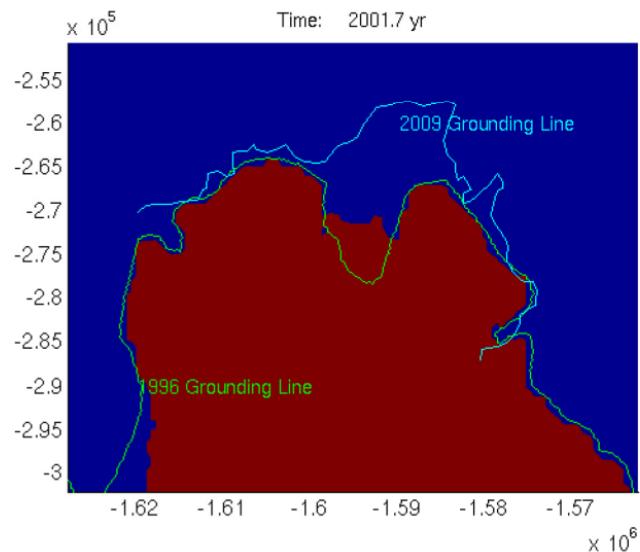
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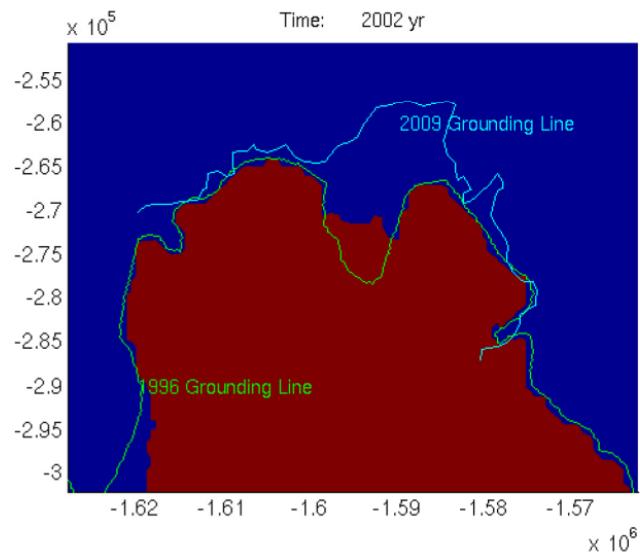
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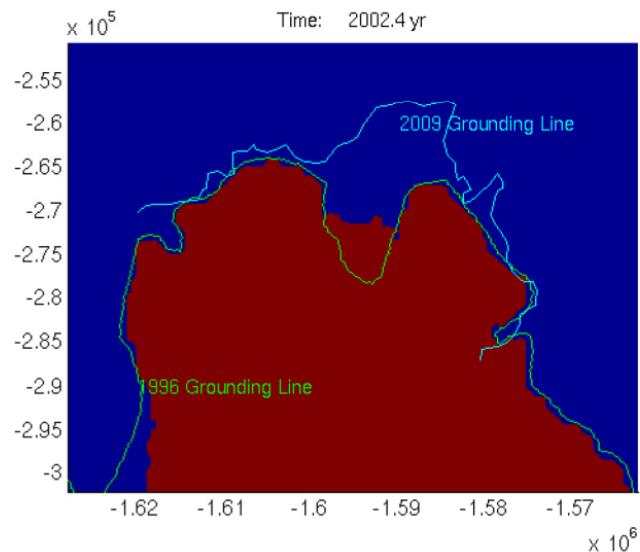
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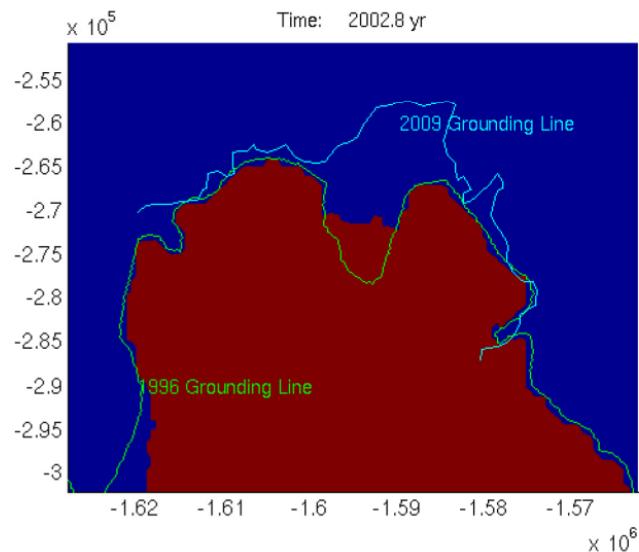
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3D Hydrostatic grounding line migration



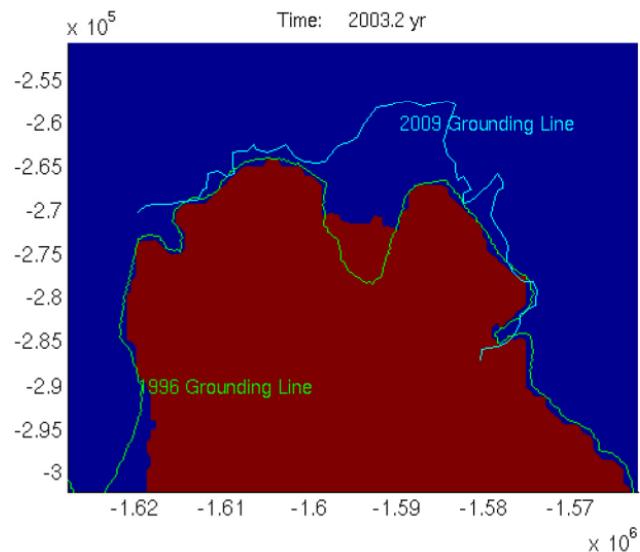
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3D Hydrostatic grounding line migration



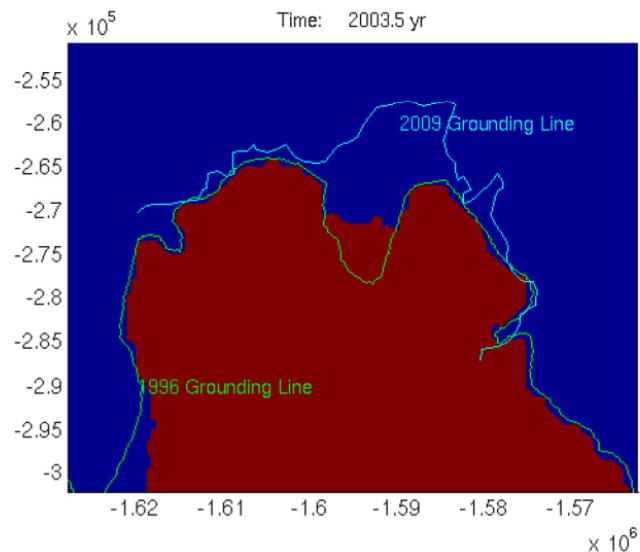
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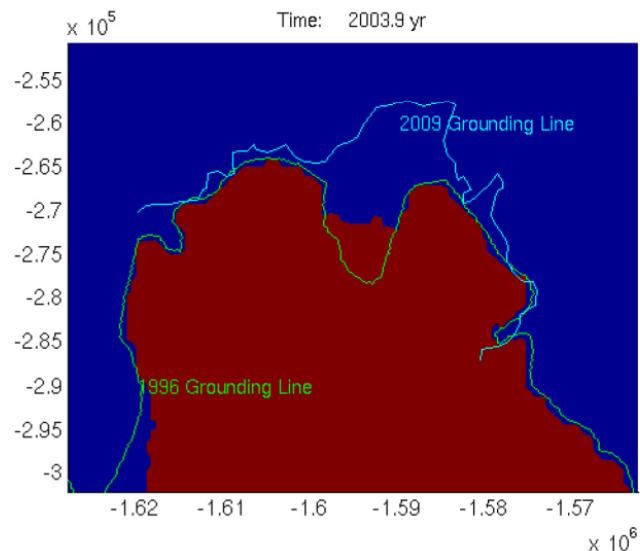
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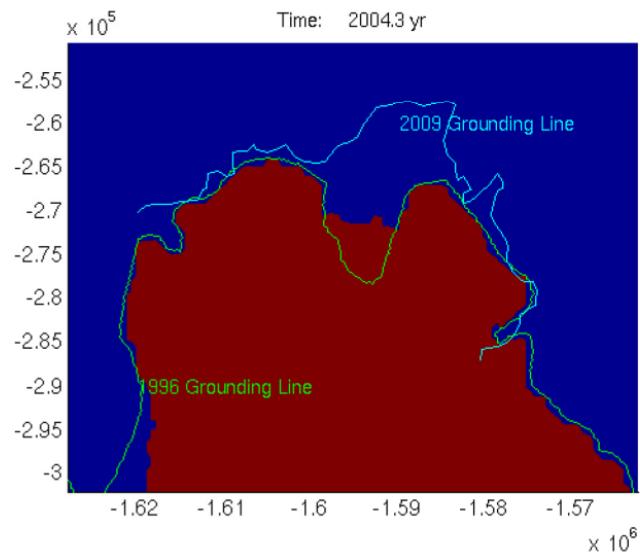
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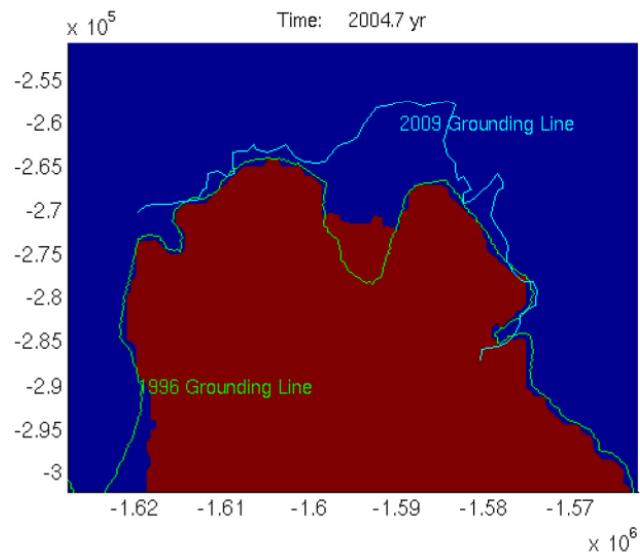
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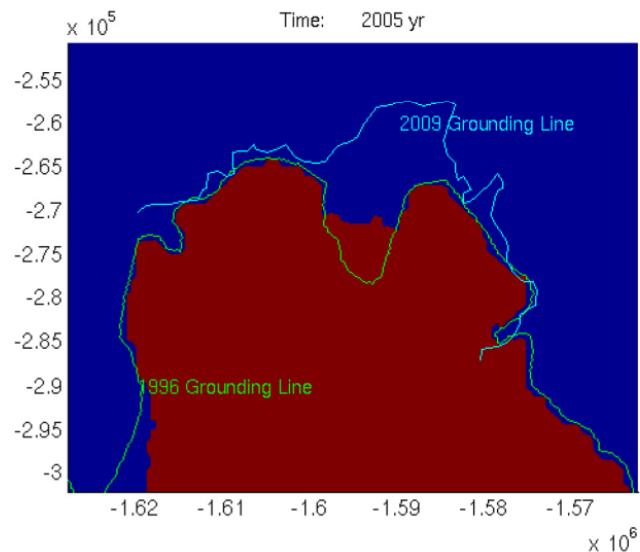
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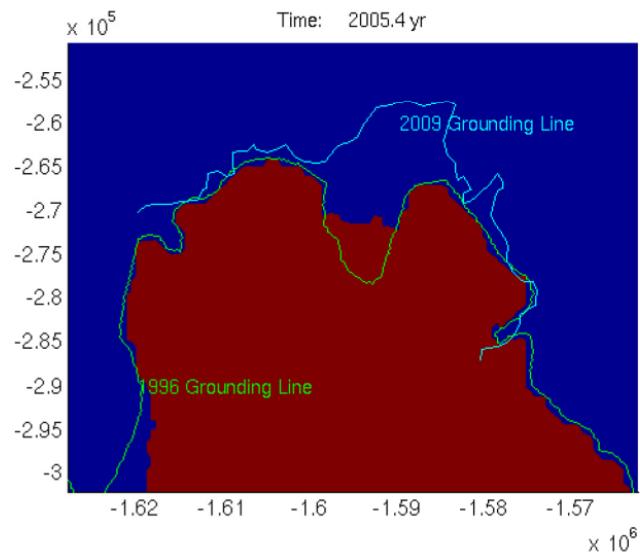
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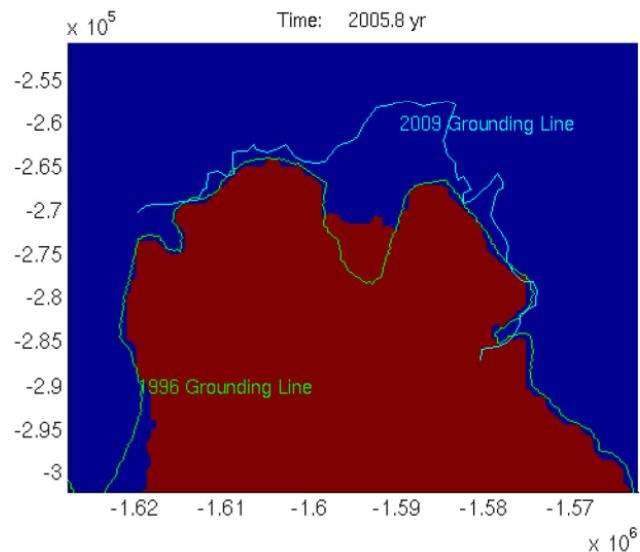
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3D Hydrostatic grounding line migration



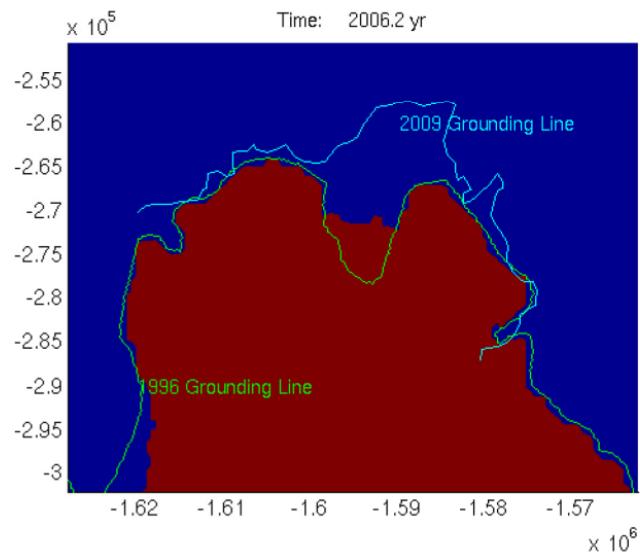
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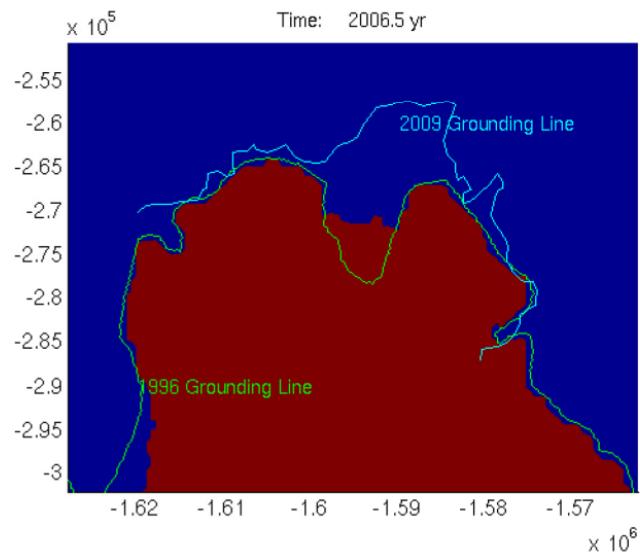
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3D Hydrostatic grounding line migration



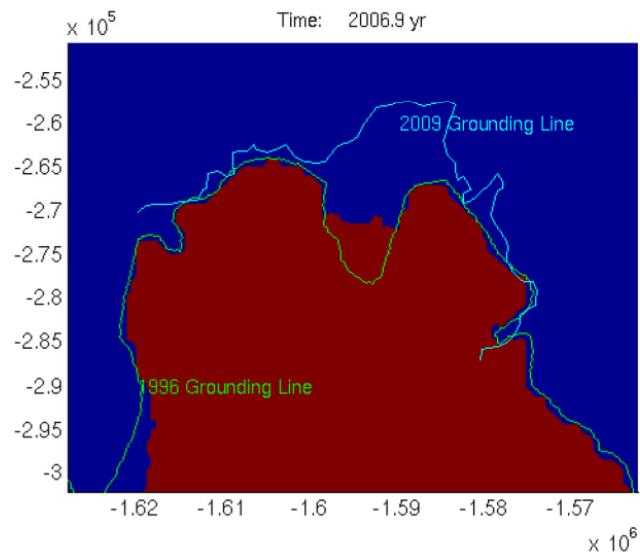
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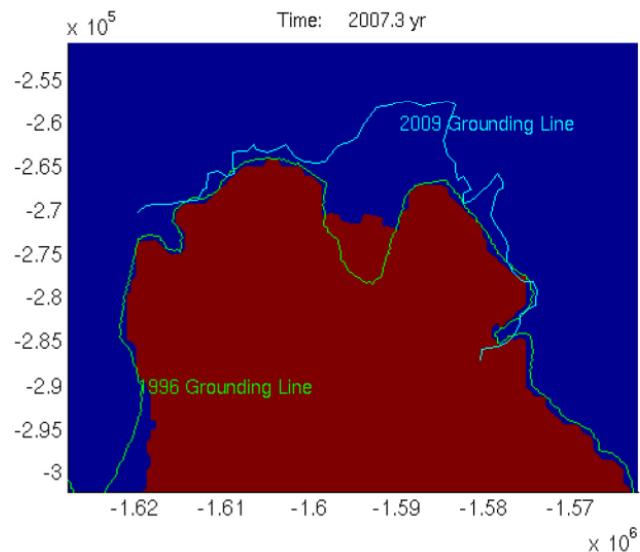
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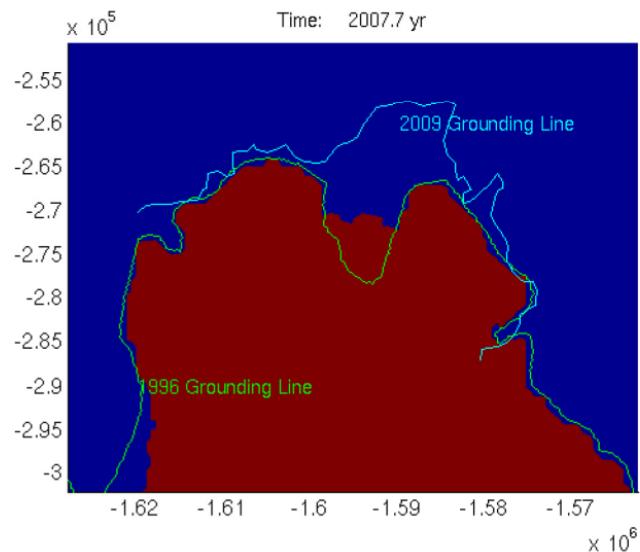
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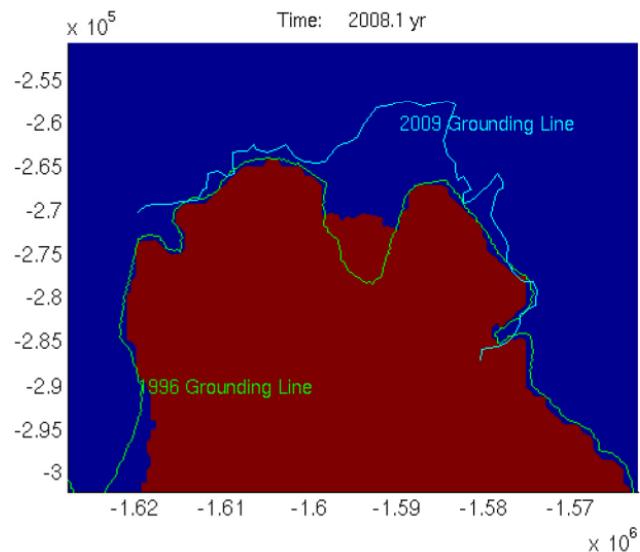
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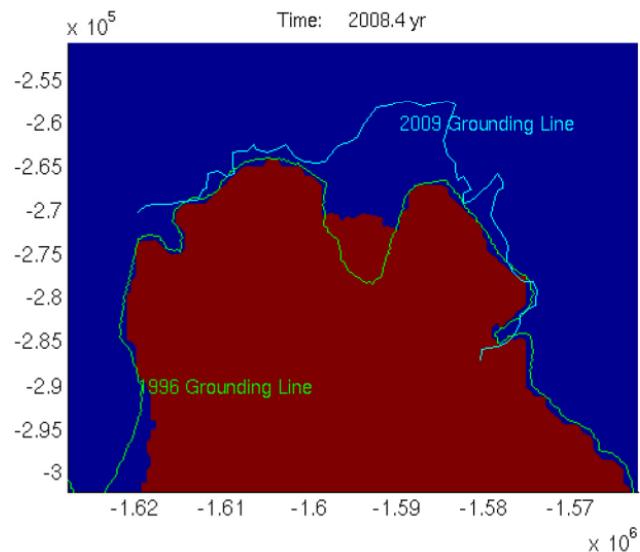
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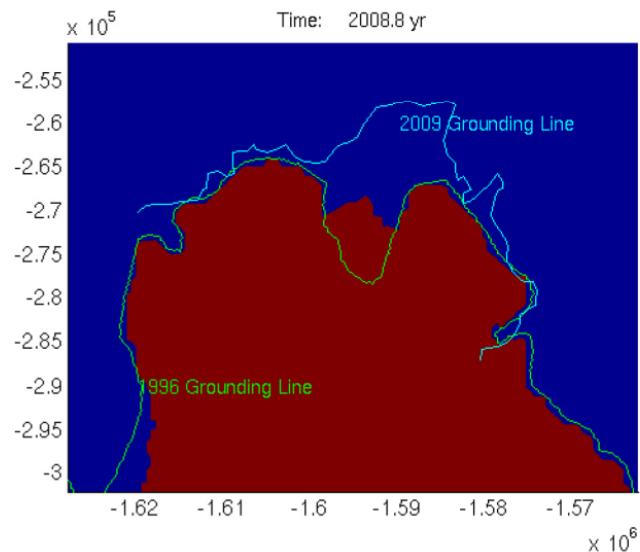
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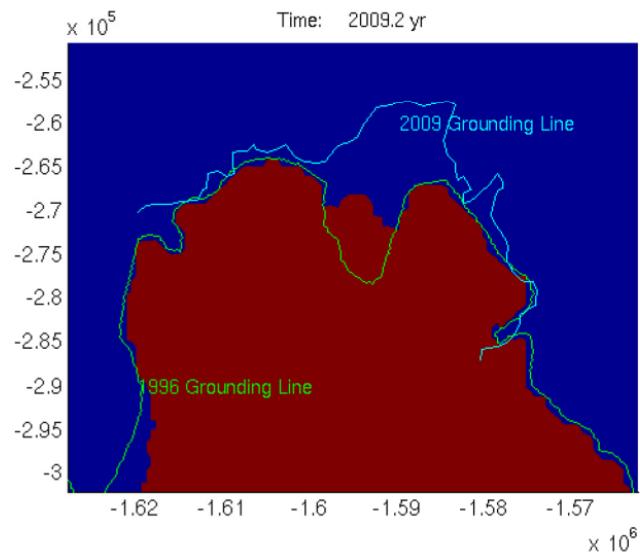
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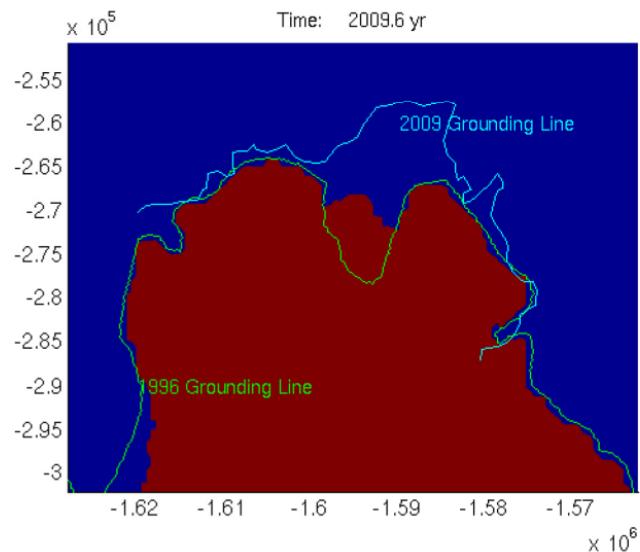
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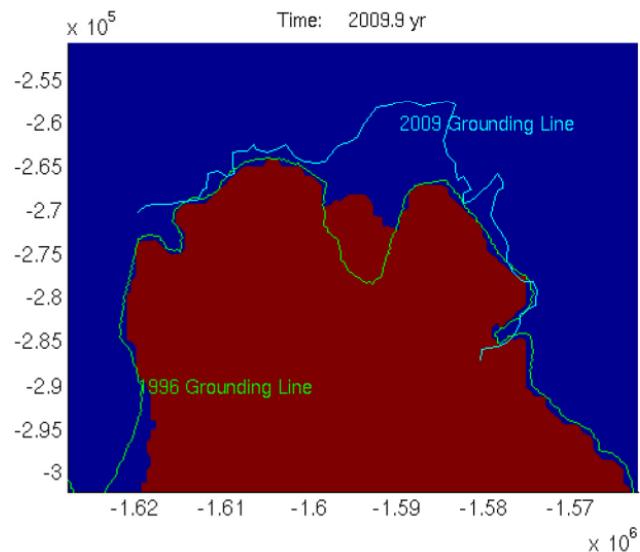
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3D Hydrostatic grounding line migration



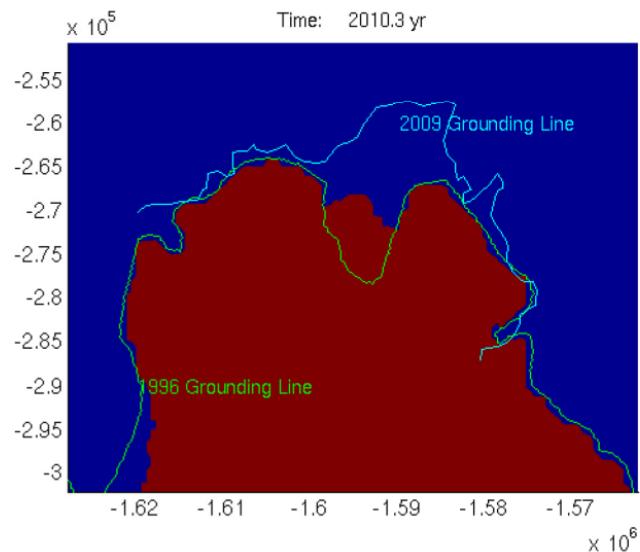
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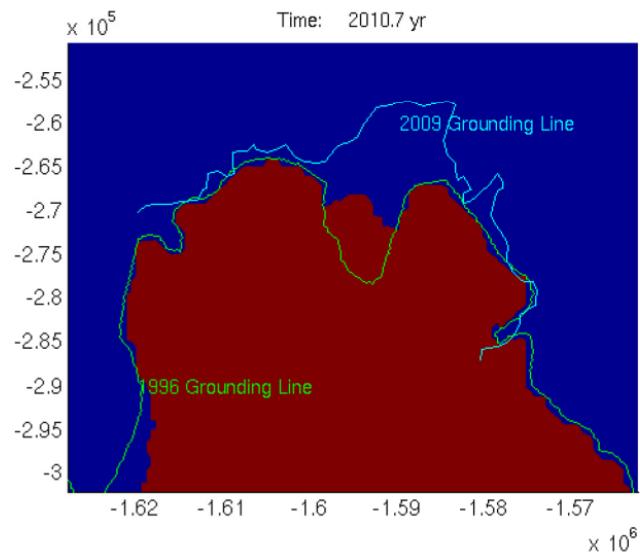
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Hydrology model

[Le Brocq et al., 2009]: the evolution of the water-film thickness (w) is given by:

$$\frac{dw}{dt} = S - \nabla \cdot (w \bar{u}_w)$$

With w the water thickness, S the basal melting rate and \bar{u}_w the depth-averaged water velocity vector.

Assuming a laminar flow between two parallel plates:

$$\bar{u}_w = \frac{w^2 \nabla \Phi}{12\mu} \quad \text{and} \quad \Phi = \rho_i g z_s + (\rho_w - \rho_i) g z_b - N$$

where μ is the water viscosity, z_s and z_b the surface and bed elevations, N the effective pressure and Φ the pressure potential.

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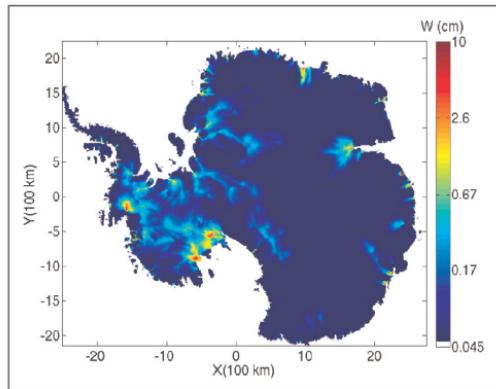
Hydrology model

Because we assume a non-arborescent drainage system, we cancel the effective pressure N :

$$\nabla\Phi = \rho_i g \nabla z_s + (\rho_w - \rho_i) g \nabla z_b$$

This set of assumptions results in the following non-linear system:

$$\frac{dw}{dt} = S - \nabla \cdot \left(\frac{w^3}{12\mu} \nabla \Phi \right)$$



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Svn/Trac

Download page:

<http://issm.jpl.nasa.gov/installation/download/>

- **Install SVN (Apache Subversion)**

- **Checkout ISSM:**

```
$ svn -username anon -password anon checkout  
https://issm.ess.uci.edu:80/svn/issm/issm
```

- **Update ISSM:**

```
$ svn update
```



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California Institute of Technology

Svn/Trac

Trac system with wiki



Welcome to ISSM (Ice Sheet System Model) developer's site

General Info

- The general website of ISSM is here: <http://issm.jpl.nasa.gov>
- [Code guidelines for developers](#)

ISSM's Development

- [TODO list.](#)
- [Correspondence between old model fields and new model fields](#)
- [Debugging status of ISSM's next version.](#)
- [Comparison of solution elapsed times between different releases.](#)

Projects

- [ISSM ISSM Meetings.](#)
- [ISSM-ECCO coupling work plan.](#)
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Nightly runs

ISSM Nightly run report

host: larsen

date: Dec-10-2011 23:00:01

OS: astrid

user: seroussi

status: all test desks have been run

release: trunk-jpl

number of successes: 2511/2658

total elapsed time: 10:03:27

number of errors: 141/2658

installation elapsed time: 3:19:25

number of failures: 6/2658

execution elapsed time: 6:44:02

List of tests

Result	Tolerance	Test id	Test name	Field checked
SUCCESS	3.3e-15<1e-13	101	SquareShelfConstrainedDiagM2dSerial	Vx
SUCCESS	1.9e-15<1e-13	101	SquareShelfConstrainedDiagM2dSerial	Vy
SUCCESS	2e-15<1e-13	101	SquareShelfConstrainedDiagM2dSerial	Vel
SUCCESS	1e-16<1e-13	101	SquareShelfConstrainedDiagM2dSerial	Pressure
SUCCESS	3.4e-15<1e-13	102	SquareShelfConstrainedDiagM2dParallel	Vx
SUCCESS	1.3e-15<1e-13	102	SquareShelfConstrainedDiagM2dParallel	Vy
SUCCESS	1.3e-15<1e-13	102	SquareShelfConstrainedDiagM2dParallel	Vel
SUCCESS	1e-16<1e-13	102	SquareShelfConstrainedDiagM2dParallel	Pressure
SUCCESS	2.1e-15<1e-13	103	SquareShelfConstrainedDiagM3dSerial	Vx
SUCCESS	9.4e-16<1e-13	103	SquareShelfConstrainedDiagM3dSerial	Vy
SUCCESS	5.3e-16<1e-13	103	SquareShelfConstrainedDiagM3dSerial	Vz
SUCCESS	1.4e-15<1e-13	103	SquareShelfConstrainedDiagM3dSerial	Vel
SUCCESS	0<1e-13	103	SquareShelfConstrainedDiagM3dSerial	Pressure
SUCCESS	3e-15<1e-13	104	SquareShelfConstrainedDiagM3dParallel	Vx
SUCCESS	1.1e-15<1e-13	104	SquareShelfConstrainedDiagM3dParallel	Vy



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Test suite

- 626 tests run on a nightly-basis
- Serial/Parallel run comparisons
- Internal checks
- Solution checks
- Numerical accuracy checks
- Run several times a day, to capture code updates which break the software

```
/Users/larour/issm/trunk/jp/Jet/Unit/NightlyRun
cd /Users/larour/issm/trunk/jp/Jet/Unit/NightlyRun
valgrind ./test126_n test227_n test311_n test417_n test580_n
valgrind ./test127_n test228_n test312_n test418_n test581_n
valgrind ./test128_n test229_n test313_n test419_n test582_n
valgrind ./test129_n test230_n test314_n test420_n test583_n
valgrind ./test130_n test231_n test315_n test421_n test584_n
valgrind ./test131_n test232_n test316_n test422_n test585_n
valgrind ./test132_n test233_n test317_n test423_n test586_n
valgrind ./test133_n test234_n test318_n test424_n test587_n
valgrind ./test134_n test235_n test319_n test425_n test588_n
valgrind ./test135_n test236_n test320_n test426_n test589_n
valgrind ./test136_n test237_n test321_n test427_n test590_n
valgrind ./test137_n test238_n test322_n test428_n test591_n
valgrind ./test138_n test239_n test323_n test429_n test592_n
valgrind ./test139_n test240_n test324_n test430_n test593_n
valgrind ./test140_n test241_n test325_n test431_n test594_n
valgrind ./test141_n test242_n test326_n test432_n test595_n
valgrind ./test142_n test243_n test327_n test433_n test596_n
valgrind ./test143_n test244_n test328_n test434_n test597_n
valgrind ./test144_n test245_n test329_n test435_n test598_n
valgrind ./test145_n test246_n test330_n test436_n test599_n
valgrind ./test146_n test247_n test331_n test437_n test600_n
valgrind ./test147_n test248_n test332_n test438_n test601_n
valgrind ./test148_n test249_n test333_n test439_n test602_n
valgrind ./test149_n test250_n test334_n test440_n test603_n
valgrind ./test150_n test251_n test335_n test441_n test604_n
valgrind ./test151_n test252_n test336_n test442_n test605_n
valgrind ./test152_n test253_n test337_n test443_n test606_n
valgrind ./test153_n test254_n test338_n test444_n test607_n
valgrind ./test154_n test255_n test339_n test445_n test608_n
valgrind ./test155_n test256_n test340_n test446_n test609_n
valgrind ./test156_n test257_n test341_n test447_n test610_n
valgrind ./test157_n test258_n test342_n test448_n test611_n
valgrind ./test158_n test259_n test343_n test449_n test612_n
valgrind ./test159_n test260_n test344_n test450_n test613_n
valgrind ./test160_n test261_n test345_n test451_n test614_n
valgrind ./test161_n test262_n test346_n test452_n test615_n
valgrind ./test162_n test263_n test347_n test453_n test616_n
valgrind ./test163_n test264_n test348_n test454_n test617_n
valgrind ./test164_n test265_n test349_n test455_n test618_n
valgrind ./test165_n test266_n test350_n test456_n test619_n
valgrind ./test166_n test267_n test351_n test457_n test620_n
valgrind ./test167_n test268_n test352_n test458_n test621_n
valgrind ./test168_n test269_n test353_n test459_n test622_n
valgrind ./test169_n test270_n test354_n test460_n test623_n
valgrind ./test170_n test271_n test355_n test461_n test624_n
valgrind ./test171_n test272_n test356_n test462_n test625_n
valgrind ./test172_n test273_n test357_n test463_n test626_n
valgrind ./test173_n test274_n test358_n test464_n test627_n
valgrind ./test174_n test275_n test359_n test465_n test628_n
valgrind ./test175_n test276_n test360_n test466_n test629_n
valgrind ./test176_n test277_n test361_n test467_n test630_n
valgrind ./test177_n test278_n test362_n test468_n test631_n
valgrind ./test178_n test279_n test363_n test469_n test632_n
valgrind ./test179_n test280_n test364_n test470_n test633_n
valgrind ./test180_n test281_n test365_n test471_n test634_n
valgrind ./test181_n test282_n test366_n test472_n test635_n
valgrind ./test182_n test283_n test367_n test473_n test636_n
valgrind ./test183_n test284_n test368_n test474_n test637_n
valgrind ./test184_n test285_n test369_n test475_n test638_n
valgrind ./test185_n test286_n test370_n test476_n test639_n
valgrind ./test186_n test287_n test371_n test477_n test640_n
valgrind ./test187_n test288_n test372_n test478_n test641_n
valgrind ./test188_n test289_n test373_n test479_n test642_n
valgrind ./test189_n test290_n test374_n test480_n test643_n
valgrind ./test190_n test291_n test375_n test481_n test644_n
valgrind ./test191_n test292_n test376_n test482_n test645_n
valgrind ./test192_n test293_n test377_n test483_n test646_n
valgrind ./test193_n test294_n test378_n test484_n test647_n
valgrind ./test194_n test295_n test379_n test485_n test648_n
valgrind ./test195_n test296_n test380_n test486_n test649_n
valgrind ./test196_n test297_n test381_n test487_n test650_n
valgrind ./test197_n test298_n test382_n test488_n test651_n
valgrind ./test198_n test299_n test383_n test489_n test652_n
valgrind ./test199_n test300_n test384_n test490_n test653_n
valgrind ./test200_n test301_n test385_n test491_n test654_n
valgrind ./test201_n test302_n test386_n test492_n test655_n
valgrind ./test202_n test303_n test387_n test493_n test656_n
valgrind ./test203_n test304_n test388_n test494_n test657_n
valgrind ./test204_n test305_n test389_n test495_n test658_n
valgrind ./test205_n test306_n test390_n test496_n test659_n
valgrind ./test206_n test307_n test391_n test497_n test660_n
valgrind ./test207_n test308_n test392_n test498_n test661_n
valgrind ./test208_n test309_n test393_n test499_n test662_n
valgrind ./test209_n test310_n test394_n test500_n test663_n
valgrind ./test211_n test311_n test395_n test501_n test664_n
valgrind ./test212_n test312_n test396_n test502_n test665_n
valgrind ./test213_n test313_n test397_n test503_n test666_n
valgrind ./test214_n test314_n test398_n test504_n test667_n
valgrind ./test215_n test315_n test399_n test505_n test668_n
valgrind ./test216_n test316_n test400_n test506_n test669_n
valgrind ./test217_n test317_n test401_n test507_n test670_n
valgrind ./test218_n test318_n test402_n test508_n test671_n
valgrind ./test219_n test319_n test403_n test509_n test672_n
valgrind ./test220_n test320_n test404_n test510_n test673_n
valgrind ./test221_n test321_n test405_n test511_n test674_n
valgrind ./test222_n test322_n test406_n test512_n test675_n
valgrind ./test223_n test323_n test407_n test513_n test676_n
valgrind ./test224_n test324_n test408_n test514_n test677_n
valgrind ./test225_n test325_n test409_n test515_n test678_n
valgrind ./test226_n test326_n test410_n test516_n test679_n
valgrind ./test227_n test327_n test411_n test517_n test680_n
```



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ISSM Ice Sheet System Model 3.3

C/C++ code documentation

Main Page Data Structures Files Directories

ISSM C/C++ Source Code Browser

Welcome !

This is the searchable browsing tool for ISSM (the Ice Sheet System Model).

These pages were automatically generated by doxygen, from comments in the ISSM source code.

Navigate the tabs above and browse through ISSM's C++ source code, files/directories, and data structures.

To find additional information regarding the use of ISSM, its current release, or the ISSM team, please visit <http://issm.jpl.nasa.gov>.

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- For help using ISSM, see our online User's Manual. Other documentation is also available including simple tutorials and FAQ.
- A current publication list is [kept here](#).
- Contact us by e-mail at issm@jpl.nasa.gov

Code Stats

Language	files	blank	comment	code	Total
C++	531	15433	17169	57344	89946
MATLAB	970	7248	13716	31608	52372
C/C++ Header	397	3047	2706	10262	16015
Objective C	32	99	0	402	501
Source Shell	9	59	98	272	429
Perl	3	21	23	240	284



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Conclusions

- ISSM represents a wide array of capabilities, geared toward solving specific cryosphere challenges such as projections of future sea level rise
- Extensive software and architecture support, as well as wide array of numerical solutions and physics implemented
- Challenges remain, such as grounding line dynamics using FS, moving margins and ice/ocean interactions



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Bibliography I

**Hecht, F. (2006).**

BAMG: Bi-dimensional anisotropic mesh generator.
Technical report, FreeFem++.

**Holland, D. and Jenkins, A. (1999).**

Modeling thermodynamic ice-ocean interactions at the base of an ice shelf.

J. Phys. Oceanogr., 29(8, Part 1):1787–1800.

**Le Brocq, A., Payne, A., Siegert, M., and Alley, R. (2009).**

A subglacial water-flow model for west antarctica.

J. Glaciol., 55(193):879–888.

A wide-angle photograph of a desolate, cold landscape. In the foreground, a flat expanse of white, textured snow or ice stretches across the frame. In the middle ground, a range of majestic, snow-capped mountains rises against a clear blue sky. The peaks are rugged, with deep shadows and bright highlights from the sunlight. The overall scene conveys a sense of vastness and silence.

Thanks!